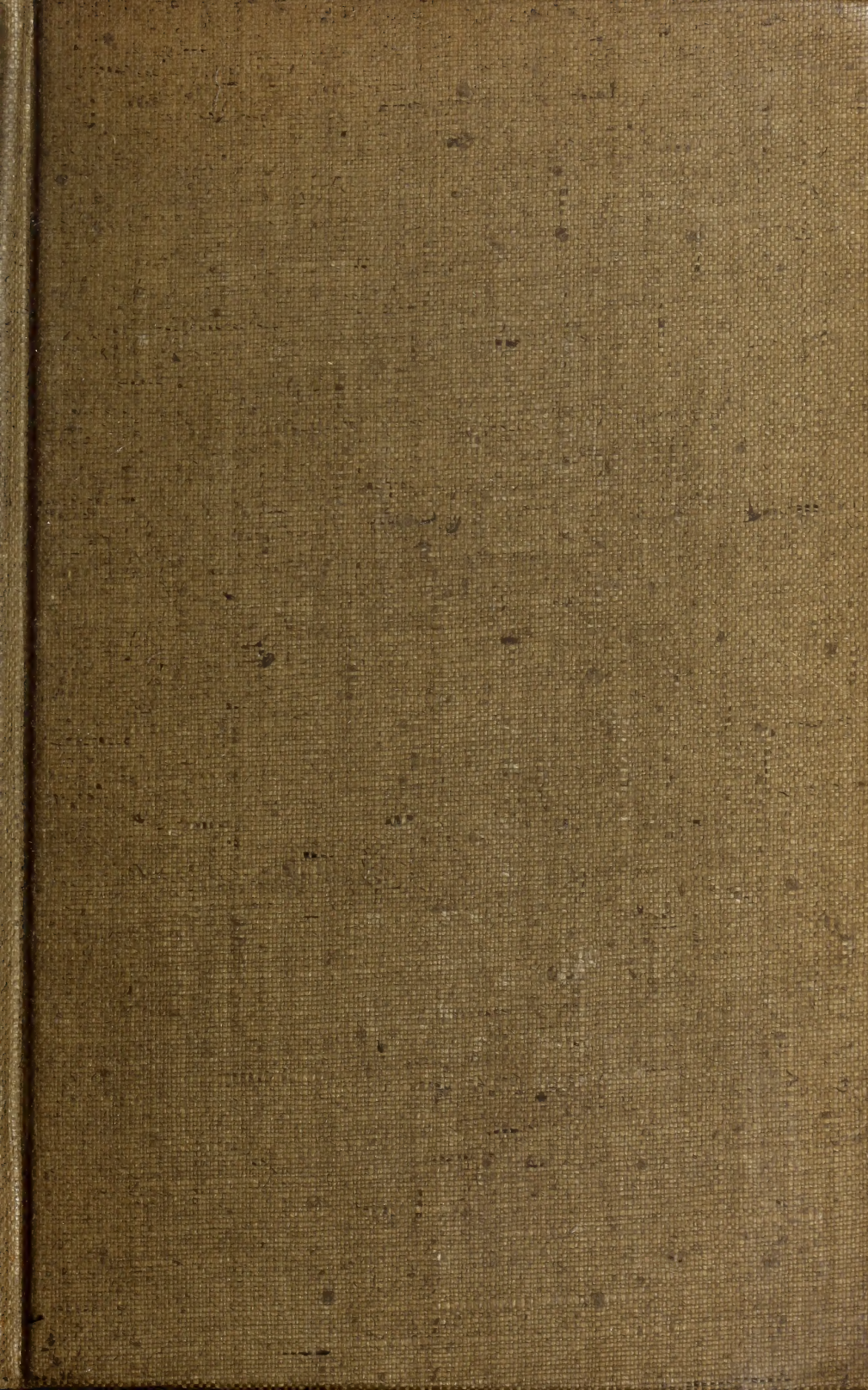




PROCEEDINGS
OF THE
Bournemouth
Natural Science
Society.

—
VOL. VIII.
—

SESSION 1915-1916.



PROCEEDINGS of the

Bournemouth Natural Science Society.



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SESSION 1915-1916.

PUBLISHED BY THE SOCIETY AT ITS ROOM,
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BOURNEMOUTH :

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Introductory Note.

THE BOURNEMOUTH NATURAL SCIENCE SOCIETY was founded in 1903, being the successor to an older society which was formed in 1883 and dissolved in 1897. Its objects are declared by the second of its rules to be "the promotion of the study of Science in all its branches, by means of Lectures, Field Meetings, the Reading and Discussion of Papers, and the formation of Sections of its members devoted to any particular branch of the Society's work."

The Sections at present working are as follows:—**Archæological and Historical, Botanical, Entomological, Geographical, Geological, Microscopical and Zoological, Photographical, and Physical.**

During the WINTER SESSION, from October to April, GENERAL and SECTIONAL MEETINGS are held. TWO GENERAL MEETINGS are usually held in each month, comprising Lectures and Demonstrations on various subjects of scientific interest, illustrated by lantern slides, diagrams, or specimens.

SECTIONAL MEETINGS.—Each Section usually holds a meeting once a month. At these meetings the papers read are more specialized and technical than at the General Meetings.

In previous years meetings have been held at 4.30 p.m., but, in consequence of the present darkened state of our streets, the time of meeting, until further notice, will usually be 3 p.m.

GENERAL MEETINGS, as a rule, are held at Trinity Hall, Lorne Park, and SECTIONAL MEETINGS at the Society's Room in the Municipal College.

Throughout the SUMMER SESSION, GENERAL EXCURSIONS to places of interest in the neighbourhood are arranged once or twice in each month. SECTIONAL EXCURSIONS are usually arranged weekly under the various sections.

The management of the Society is vested in a Council, which is elected at the Annual General Meeting, held in October.

The Members are elected by the Council, and pay an annual subscription of Ten Shillings for full membership (admitting to all meetings and excursions for the year). Visitors to Bournemouth are permitted to join for the Winter or Summer Sessions on payment of seven shillings and sixpence, if approved by the Council.

The Society is endeavouring to lay the foundations of a MUSEUM by acquiring collections of archæological, botanical geological, zoological, and other specimens of scientific interest. A good beginning has already been made in several directions, especially by the acquisition of the valuable Dent Collection of Barton Fossils. Particulars as to the objects and hopes of the Society in this direction will be found in the special article contributed by Sir Daniel Morris to Vol. V. of the Society's Proceedings.

A MONTHLY NOTICE, giving full details of all meetings, etc., is posted to every member before the beginning of each month, and a volume of Proceedings is published every year.

Application Forms for Membership, and further particulars, can be obtained from the

HON. SECRETARY,

Bournemouth Natural Science Society,

Municipal College,

Bournemouth.

Bournemouth Natural Science Society.

OFFICERS AND COUNCIL FOR 1916-17.

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THE RT. HON. THE EARL OF MALMESBURY, D.L., J.P.

Vice-Presidents:

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DR. S. MCCALMONT HILL, D.C.L.
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REV. E. F. LINTON, M.A., F.L.S.
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D.SC., D.C.L., F.L.S.

DR. W. T. ORD, F.G.S.
HUBERT PAINTER, B.SC., F.C.S.
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DR. A. RANSOME, M.A., M.D., F.R.C.P.,
F.R.S.
MISS C. AGNES ROOPER.
R. V. SHERRING, F.L.S.
DR. J. ROBERTS THOMSON, M.D., F.R.C.P.,
J.P.

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SIR DANIEL MORRIS, K.C.M.G., D.SC., D.C.L.

Deputy-Chairman of Council:

W. MUNN RANKIN, M.SC., B.SC.

Council:

THE OFFICERS (ex-officio) and

HENRY BACKHOUSE, F.R.H.S.
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J. M. FRENCH.
R. O'B. FURLONG, C.B., M.A., J.P.
REV. C. O. S. HATTON, B.A.
T. J. P. JEFFERY.

HENRY LE JEUNE.
JOSEPH NEALE, B.A.
J. H. SCOTT, M.E., M.I.M.C.E.
R. V. SHERRING, F.L.S.
J. H. RALPH SMYTHE, J.P.
W. J. WOODHOUSE, A.C.P.

Chairmen of Sections:

Archæological and Historical: REV. H. SHAEN SOLLY, M.A.

Botanical: MISS C. AGNES ROOPER.

Entomological: F. G. PENROSE, M.D., F.R.C.P., F.Z.S.

Geographical: CLAUDE LYON.

Geological: W. MUNN RANKIN, M.SC., B.SC.

Photographical and Record: R. Y. BANKS.

Physical: HUBERT PAINTER, B.SC., F.C.S.

Zoological and Microscopical: F. G. PENROSE, M.D., F.R.C.P., F.Z.S.

Hon. Treasurer:

GEORGE BRUMELL, A.R.I.B.A.

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Joint Hon. Secretaries { R. A. DE PAIVA, San Remo, Carysfort Road, Bournemouth
THOS. CAPPER, M.A., B.SC., Ropley, Stirling Road,
Bournemouth.

Assistant Secretary: J. F. SPENCER, Glenthorne, Richmond Park Road,
Bournemouth.

Hon. Librarian:

HENRY J. ELLIS.

Hon. Editor:

HUBERT PAINTER, B.SC., F.C.S.

Hon. Auditors:

E. BICKER.

E. W. BARLOW, B.SC., F.R.A.S.

Bankers:

NATIONAL PROVINCIAL BANK OF ENGLAND, BOURNEMOUTH.

Past Presidents:

1903-4 ...	J. E. BEALE (Mayor of Bournemouth).
1904-5—1905-6 ...	G. E. J. CRALLAN, M.A., M.B., M.R.C.S.
1906-7 ...	H. J. WADDINGTON, F.L.S.
1907-8—1908-9 ...	DR. A. RANSOME, M.A., F.R.C.P., F.R.S.
1909-10 ...	DR. A. SMITH WOODWARD, LL.D., F.R.S., F.L.S., F.G.S.
1910-11 ...	DR. DUKINFELD H. SCOTT, M.A., LL.D., F.R.S., F.L.S., F.G.S.
1911-12—1912-13 ...	SIR E. RAY LANKESTER, K.C.B., M.A., LL.D., F.R.S., F.L.S.
1913-14—1914-15 ...	SIR DANIEL MORRIS, K.C.M.G., J.P., M.A., D.SC., D.C.L., F.L.S.
—1915-16 ...	

Annual Meeting, 1916

THE Thirteenth Annual Meeting was held in the Society's Room on October 28th, Sir Daniel Morris, President of the Society, being in the chair.

The Council's Report and the Hon. Treasurer's statement of accounts were read. The latter showed receipts £295 5s. 8d. and payments £162 os. 10d., leaving a balance in hand of £133 4s. 10d. The Council's Report indicated that the Society had continued its successful career, and that the Membership was practically the same as at the corresponding period last year, the numbers on September 30th being 406, compared with 408 in 1915. There had been 60 Meetings and Excursions during the year.

The reports of the sections were read by their respective Chairmen and the Hon. Librarian presented his report.

Sir Daniel Morris, in a few appropriate remarks, proposed the election of the Earl of Malmesbury as President of the Society for 1916-17. This was seconded by Dr. Moorhead and carried unanimously. A hearty vote of thanks, proposed by Mr. Backhouse, who spoke in cordial terms of the valuable services rendered to the Society by the retiring President, Sir Daniel Morris, during the three years of his presidency, was seconded by Mr. Jeffery, and carried unanimously. Sir Daniel Morris briefly replied.

The following Vice-Presidents were then elected on the proposition of Mr. Furlong, seconded by Mr. J. H. Ralph Smythe, viz., Mr. Hy. Backhouse, Dr. Crallan, Dr. McCalmont Hill, Mr. Jas. E. Liddiard, the Rev. E. F. Linton, Sir D. Morris, Dr. Ord, Mr. H. Painter, Dr. F. G. Penrose, Dr. A. Ransome, Miss C. Agnes Rooper, Mr. R. V. Sherring, and Dr. J. Roberts Thomson.

The officers who had served during the past year were re-elected, proposed by Mr. Geo. de Castro, seconded by Mr. A. Gray. The Chairman then proposed and Mr. W. H. Scott seconded the election of the twelve members of Council in accordance with the rules. There were three vacancies, which were filled by the Rev. C. O. S. Hatton, Mr. W. J. Woodhouse, and Mr. J. Herbert Dyer, and the remaining nine members were re-elected.

A vote of thanks was proposed by Mr. F. B. Taylor, seconded by the Rev. J. Pate, to the Auditors, Mr. E. Bicker and Mr. E. W. Barlow, who were re-elected.

The Meeting was closed by a vote of thanks to the Chairman, proposed by Mr. Claude Lyon, seconded by the Rev. Hy. Shaen Selly.

Summary of Cash Account for year ending 30th September, 1916.

RECEIPTS.

	Amounts for previous year.	
	£ s. d.	£ s. d.
Balance at Bank on 1st Oct., 1915	99 12 11	55 17 2
Members' Subscriptions	174 12 6	191 12 6
Subscriptions in Advance, 1916-17	3 0 0	2 0 0
Sales of Volumes of Proceedings and Presidential Address ...	1 16 3	2 0 6
Sales of "Natural History Bournemouth"	3 11 8	3 15 3
Surplus from Excursions	12 12 4	8 6 9

£295 5 8

PAYMENTS.

	Amounts for previous year.	
	£ s. d.	£ s. d.
Rent of Room at Municipal College	35 0 0	25 0 0
Hire of Trinity Hall	3 15 0	5 0 0
Salary of Assistant Secretary ...	10 0 0	10 0 0
Printing and Stationery	19 13 1	21 12 8
	(Year 1912-14)	
Volume VII. of Proceedings ...	27 17 3	55 16 2
Furniture and upkeep of Room ...	3 16 8	2 1 6
Expenses of Lectures	18 16 5	17 5 8
Postage	12 14 1	17 11 10
Subscriptions to other Societies ...	2 17 0	3 18 0
Insurance	1 7 7	1 9 7
In connection with Collections of Specimens and Records	19 7 4	18 13 2
Books and Binding	4 14 9	2 6 8
Sundries	2 1 8	2 6 7
	<u>£162 0 10</u>	
Balance at Bank	133 4 10	
	<u>£295 5 8</u>	

Examined with the Books and Vouchers and found correct.

EDWARD BICKER.

26th October, 1916.

Auditor.

Council's Report for 1916.

IN presenting the Thirteenth Annual Report, the Council has the pleasure to record another year of activity and usefulness, and, although there were several resignations at the end of the year, the Membership has nearly recovered, the numbers on 30th September being 406, compared with 408 at the corresponding date last year.

During the year General and other Meetings were held as follows, viz. :—

- Annual Meeting.
- Presidential Address.
- 7 General Lectures.
- 32 Sectional Lectures.
- 3 General Excursions.
- 15 Sectional Excursions,

making a total of 59 Meetings and Excursions, and in addition to these, a visit was paid to the Rose Gardens at Michelgrove House on July 7th by the kind invitation of Mr. Walter Child Clark.

The General Lectures were :—

- *Nov. 13.—Presidential Address, “Hardy British Trees,” by Sir Daniel Morris, K.C.M.G., etc.
- *Nov. 27.—“Soil and Plant Food,” by Dr. E. J. Russell, D.Sc.
- *Dec. 11.—“Spiders at Home,” by Mr. E. J. E. Creese, F.Z.S., F.R.M.S.

1916.

- *Jan. 29.—“The Austrian Tyrol,” by Rev. W. H. Windle Cooper, M.A., F.R.G.S.
- *Feb. 12.—“A Walk Around Thebes,” by Mr. Claude Lyon.
- *Mar. 11.—“Some Geographical, Historical, and other Particulars of the South Pacific Island Kingdom of Tonga,” by Mr. Jas. E. Liddiard, F.R.G.S.
- *Mar. 18.—“Eucalyptus and other Australian Plants Acclimatised in and around Bournemouth,” by the President, Sir Daniel Morris, K.C.M.G., etc.
- *April 29.—“The Uses of Carbon” (Carbon Series), by Mr. H. Painter, B.Sc., F.C.S.

* Illustrated by Lantern Slides.

The General Excursions and their Conductors were :—

1916.

- May 31.—Bindon Abbey and Wool Manor House, Rev. Hy. Shaen Solly, M.A.
- June 22.—Wolfeton House via the Hardy County, Mr. W. Munn Rankin, M.Sc., B.Sc., and Mr. Harry Pouncy.
- July 15.—Lulworth Castle, Rev. Hy. Shaen Solly, M.A.

The Sectional Lectures were as follows, viz. :—

In the Archæological and Historical Section.

1915.

- *Nov. 23.—“The Catacombs of Rome,” by Rev. Hy. Shaen Solly, M.A.
- Dec. 14.—“The Ancient Earthworks on Cranborne Chase,” by Mr. Heywood Sumner, F.S.A.

1916.

- Jan. 26.—“History and Traces of Phœnician Intercourse with the British Isles,” by Rev. F. A. Allen, M.A.
 *Feb. 22.—“On the Origin of the Authorised Version of the English Bible,” by Mr. Hy. J. Ellis.
 *Mar. 8.—“A Ramble in and around Christchurch Priory with Note Book and Camera” (Archæological and Photographic), by Mr. R. Y. Banks.

In the Botanical Section.

1915.

- *Nov. 18.—“Flowers I found in Cornwall and Devon last June,” by Miss C. Agnes Rooper.

1916.

- Jan. 6.—“The Ferns of Purbeck and Some Varieties,” by Mr. C. B. Green.
 Feb. 6.—“On Conducting a Wild Flower Exhibition,” by Mr. J. F. Rayner, F.R.H.S.
 *Feb. 24.—“The Importance of Carbon in Plants” (Carbon Series), by Rev. Prof. Geo. Henslow, M.A., F.L.S., F.G.S.

In the Entomological Section.

1915.

- Dec. 10.—“Simulium, supposed carrier of the disease Pellagra,” by Mr. J. Omer Cooper.

1916.

- Jan. 28.—“The Nomenclature of the Lepidopterous Wing,” by Mr. W. Parkinson Curtis, F.E.S.
 Feb. 11.—“Among the Beetles,” by Mr. Jos. Neale, B.A.

In the Geographical Section.

1915.

- Nov. 20.—“The Work of the Section,” by Mr. Geo. de Castro, M.R.C.S.

1916.

- Feb. 26.—“Demonstrations in Geographical Methods,” by Mr. W. J. Woodhouse, A.C.P.
 *Mar. 15.—“Frontiers,” by Mr. C. B. Fawcett, B.Litt.
 Mar. 25.—“A Study of Carbon in Relation to Geography” (Carbon Series), by Mr. W. J. Woodhouse, A.C.P.
 April 7.—“The Practical Making of a Relief Map,” by Mr. A. Barraclough, M.A., F.R.G.S.
 May 12.—“Map Drawing, its Aims and Objects,” by Mr. W. J. Woodhouse, A.C.P.

In the Geological Section.

1915.

- *Dec. 8.—“Mountains, their Origin and Decay,” by Mr. W. Munn Rankin, M.Sc., B.Sc.

1916.

- *Jan. 19.—“An Introduction to the Geology of N.E. France and Belgium,” by Mr. W. Munn Rankin, M.Sc., B.Sc.
 *Feb. 16.—“Volcanoes, their Origin and Nature,” by Dr. Wm. Gosse, M.D., D.P.H.
 *Mar. 29.—“The Geology of Carbon, Part I., Coal and the Diamond” (Carbon Series), by Mr. W. Munn Rankin, M.Sc., B.Sc.
 *April 12.—“The Geology of Carbon, Part II., the Diamond, Graphite, and the Mineral Oils” (Carbon Series), by Mr. W. Munn Rankin, M.Sc., B.Sc.

In the Photographic and Record Section.

1915.

- *Nov. 25.—“On the Work of the Season,” by Mr. R. Y. Banks.

1916.

- *Jan. 12.—“Photography and Focus” Prize Slides for 1915, by Mr. R. Y. Banks.

In the Physical Section.

1915.

- Dec. 4.—“Chemistry and the War,” by Mr. Hubert Painter, B.Sc., F.C.S.

1916.

- Jan. 15.—“Carbon, an Outline of the Chemistry of the Element and a few of its Compounds” (Carbon Series), by Mr. Hubert Painter, B.Sc., F.C.S.
 *Feb. 29.—“Are there other Inhabited Worlds?” by Mr. Thos. Capper, M.A., B.Sc.
 *Mar. 23.—“The Study of Splashes,” by Prof. A. M. Worthington, C.B., F.R.S.
 April 8.—“Astronomical Sidelights on Archæological Problems” (Physical and Archæological), by Mr. E. W. Barlow, B.Sc., F.R.A.S.

In the Zoological Section.

1916.

- *Jan. 20.—“A Chat about Birds,” by Dr. F. G. Penrose, M.D., F.R.C.P., F.Z.S.
 April 6.—“A Display of Half Plate Autochrome Pictures (Zoological and Photographic), by Dr. F. G. Penrose, M.D., F.R.C.P., F.Z.S.
 * Illustrated by Lantern Slides.

The Excursions in the various Sections and their Conductors were:—

1916.

- April 19.—Redhill and Muscliff, Mr. R. V. Sherring, F.L.S. (Botanical.)
 May 13.—Hengistbury Head, Mr. W. Munn Rankin, M.Sc., B.Sc. (Geological.)
 May 22.—West Parley and West Moors, Mr. R. V. Sherring, F.L.S. (Botanical.)
 May 27.—Studland, Mr. W. Munn Rankin, M.Sc., B.Sc. (Geological and Archæological.)
 June 1.—Ashton Court and Branksome Chine, Mr. Claude Lyon. (Geographical.)
 June 3.—Head Waters of the Beaulieu River, Mr. Claude Lyon and Mr. C. B. Fawcett, B.Litt. (Geographical.)
 June 8.—Wareham and Ridge, Mr. C. B. Green. (Botanical.)
 June 17.—Heron Court and Kinson, Sir D. Morris, K.C.M.G., and Mr. E. Dodshon, LL.B. (Photographic and Archæological.)
 June 24.—Hengistbury Head, Rev. Hy. Shaen Solly, M.A., and Mr. Hy. J. Ellis. (Archæological.)
 June 29.—Swanage, Dr. F. G. Penrose, M.D., F.R.C.P., F.Z.S., and Mr. W. Munn Rankin, M.Sc., B.Sc. (Entomological, Geological and Zoological.)
 July 4.—Wimborne and Cow Grove, Mr. R. V. Sherring, F.L.S. (Botanical.)
 July 11.—Bournemouth Waterworks and Munition Works of Messrs. J. E. Flower & Co., at Wimborne, Mr. H. Painter, B.Sc., F.C.S., and Mr. Hy. Le Jeune. (Physical.)
 July 22.—Bloxworth House and Woolsbarrow, Mr. Claude Lyon. (Geographical and Archæological.)
 July 27.—Woodford Castle, Rev. Hy. Shaen Solly, M.A., and Mr. W. Munn Rankin, M.Sc., B.Sc. (Archæological and Geological.)
 Sept. 28.—Fungus Foray in the New Forest, Mr. J. F. Rayner, F.R.H.S. (Botanical.)

At the last Annual Meeting held in the Society's Room, Municipal College, on October 30th, 1915, Sir Daniel Morris, K.C.M.G., J.P., M.A., etc., was unanimously re-elected President and gave his Presidential Address in Trinity Hall on November 13th.

The Earl of Malmesbury has kindly consented to be nominated for election as President for 1916-17.

During the Winter, owing to the restrictions of the Lighting Order, the Lectures were given at three o'clock instead of at 4.30, and in view of the increased stringency of the regulations, the Council recommends the same course to be followed this Winter. The Lectures given during the Winter Session were fully up to their usual high level; one in particular deserves special notice. It was entitled "A Study of Splashes," and was given on March 23rd by Professor A. M. Worthington, C.B., F.R.S.: the effect of dropping a sphere into water and its passage through the liquid were studied by the aid of instantaneous photographs taken by electric flashes and representing the condition of affairs at intervals of 1-500th of a second.

Among the Sectional Lectures was a series treating of Carbon in its Physical, Geological, Geographical and Botanical aspects, followed by a General Lecture on "The Uses of Carbon," and it is proposed to hold a similar series in the coming session in connection with some other kindred subject.

Sir Daniel Morris attended as Delegate from this Society to the Meeting of the British Association at Newcastle in September last. The next Meeting of the Association, as already announced, will be held in Bournemouth in September next.

The Society has sustained a severe loss by the death of Mr. George Gibson Hamilton, M.B., F.R.C.S., F.R.H.S., which took place on December 19th last after a short illness. His lectures, illustrated by colour photography, which was a favourite study of his, will be fresh in the memory of all. He was Chairman of Council for rather more than a year before his death. He was a leading spirit in the organization of the Congress of the South-Eastern Union of Scientific Societies in June, 1914, and the *Conversazione* held in the Municipal College owed much of its success to the large collection of scientific and interesting exhibits brought together by his untiring efforts.

The Council has also to record the loss of one of its valued members by the death of its former Hon. Secretary, Mr. Theophilus Michell, M.Inst.C.E. He had been in ill-health for some time since his resignation of his official position. He was very methodical and introduced some useful alterations in the inner working of the Society.

The Council also regrets the loss by death of Dr. H. Colley March, F.S.A., M.R.S.A.I., F.A.I., and of Admiral C. E. Gissing, Mrs. Aldridge, and Miss E. H. Southby.

The Society will learn with great regret that Mr. R.V. Sherring, F.L.S., has tendered his resignation as Secretary to the Botanical Section. He has devoted himself for many years to Botanical work in connection with the Herbarium and he organized and conducted successful excursions of the Section, going carefully over the ground beforehand and making all the necessary arrangements. The Council desires to record its high appreciation of his strenuous work for the Society.

The Society also desires to express its deep appreciation of the services of Mr. W. Parkinson Curtis, F.E.S., and of his brother, Mr. Eustace Harker Curtis, in undertaking the arrangement of the Batley Collection of Birds' Nests and Eggs.

The principal donations to the Society were several books, referred to in the Hon. Librarian's Report, and

- 78 Lantern Slides belonging to the late Mr. Geo. G. Hamilton, M.B., F.R.C.S., presented by Mrs. Hamilton.
- 64 Lantern Slides of Christchurch, presented by Mr. R. Y. Banks.
- 45 Lantern Slides of Rome, presented by Rev. Hy. Shaen Solly, M.A.
- 8 six-inch Ordnance Maps of the New Forest (Lyndhurst district), presented by Mr. F. B. Taylor, B.A.

In conclusion, the Council desires to record its appreciation of the kindness of the Right Hon. the Earl of Malmesbury, D.L., J.P., the Right Hon. the Earl of Ilchester, J.P., Mr. and Mrs. Lane, Mrs. Weld-Blundell, and Mr. and Mrs. Lee, who have given permission to visit their premises and grounds, and also to express its best thanks to the donors of other gifts to the Society and to the Lecturers and Conductors of Excursions for their services, which have been much appreciated.



The late Clement Reid, F.R.S., F.L.S., F.G.S.

WE deeply regret to record the death of Mr. Clement Reid, one of the most distinguished of our Honorary Members. Mr. Reid manifested in many ways his interest in the Society and, on February 23rd, 1915, read a most valuable paper before the Geological Section. This paper, entitled "Ancient Rivers of Bournemouth," appeared in full in Vol. vi. of the Proceedings. We are indebted for the following brief notice to the courtesy of a friend of the late eminent geologist:—

"Mr. Clement Reid, F.R.S., late District Geologist on H.M. Geographical Survey, died at his home 'One Acre,' Milford-on-Sea, on December 10th, aged 63.

"From 1901 till he retired in 1914 he had charge of the geological survey of Cornwall and the district round London, but the greater part of his life was spent in the geological survey of districts of the East and South of England. It was when engaged upon this work that he made especially his own the study of the Tertiary and Pleistocene deposits of these parts.

"This study led him into special branches of geological science. He devoted, first his leisure and later his time of retirement, to the study of the fossil botany of Tertiary, Pleistocene and more recent deposits both in England and parts of the Continent.

"His wish was to tie on the natural history of the present with that of the past and to show its course of development by a fairly continuous record and so to trace the probable physical and climatic changes through which our country has passed in the more recent geological and in pre-historic times."



Hon. Librarian's Report, 1915-16.

I HAVE to report that during the session of 1915-1916 the Society has received a number of additions to its Library, and all sections have benefited in a more or less degree. The chief accessions are:—

1. Windle's "The Wessex of Thos. Hardy," presented by the Rev. W. H. Windle Cooper and Mr. E. Cooper.
2. Eleven papers contributed to the Transactions of the Royal and other Societies, written by, and presented by Dr. Dukinfield Scott and Mrs. Scott.
3. Gregory's "British Violets" and Tansley's "Types of British Vegetation," presented by the Botanical Section.
4. "The Festival Book of Salisbury," 1916, presented by Mr. Heywood Sumner.
5. Verrall's "British Diptera," with additions by F. C. Adams, presented by Miss E. K. Pearce.
6. "A Study of Splashes," by Professor A. M. Worthington, presented by Mr. R. A. de Paiva.
7. Peary's "Voyage to the North Pole," presented anonymously.
8. "The Country Side," vols. 4, 5, 6, 7; "The Country Side Monthly," vols. 1, 2, 3; "Science Gossip" for 1865-1872; Proctor's "Nature Studies"; Lydekkers "Cats, Civets and Mongooses"; Tristram's "Natural History of the Bible," presented by Mr. J. Omer Cooper and Mr. W. Omer Cooper, F.L.S.
9. Belzung's "Physiologie Vegetale," presented by Miss Rooper.
10. "The American Journal of Geography" for two years; "American Bird Lore" for 1915; "Report of the American Museum of Natural History" for 1915; The American "Geographical Review," vol. 1., January-June, 1916, presented by Mr. G. R. MacDougall.
11. The "Journals of Botany" and of "Ecology," "Knowledge" and the publications of the "Palæontographical Society" are subscribed for annually by the Society.

A few other works and papers of minor importance have been received, and assistance in binding has been given by members.

We exchange volumes of our Proceedings with a number of Societies having kindred scientific aims:—

1. Ashmolean Natural History Society of Oxfordshire.
2. Belfast Naturalists' Field Club.
3. Cambridge Antiquarian Society.
4. Caradoc and Severn Valley Field Club.
5. Chester Society of Natural History.
6. Cotteswold Naturalists' Field Club.
7. Croydon Natural History and Scientific Society.
8. Dorset Natural History and Antiquarian Field Club.
9. Hampshire Field Club and Archæological Society.
10. Hastings and East Sussex Natural History Society.
11. South London Entomological and Natural History Society.
12. Torquay Natural History Society.
13. South-Eastern Union of Scientific Societies.

I would wish particularly to draw the attention of our Entomological Members to the valuable Proceedings of the South London Society, of which we have obtained the volumes from 1900-1916. We have also now a complete set of the Hampshire Field Club's Proceedings to date.

Measures have recently been taken by the Council to provide more ample bookcase accommodation, and it is hoped shortly to make many more books available for the use of members.

H. J. ELLIS, Hon. Librarian.



Report of the Delegate to the British Association Meeting of 1916.

SIR Daniel Morris, Delegate of the Bournemouth Natural Science Society at the Annual Conference of Delegates of Corresponding Societies at the Meeting of the British Association held at Newcastle-upon-Tyne, from September 5th to September 9th, 1916, reported as follows:—

On this occasion the President of the Conference was Professor G. A. Lebour, D.Sc., F.G.S.; the Vice-President, Mr. Thomas Sheppard, M.Sc., F.G.S., and the Secretary, Mr. Wilfred Mark Webb, F.L.S.

The President delivered an address on "Co-operation," and drew attention to the desirability of renewed action on the part of Naturalists, Field Clubs and others in undertaking systematic research into problems still awaiting solution in their several districts. From a geological point of view, Professor Lebour suggested the following lines of observation and research:—

- (a) A detailed mapping of stratigraphical sub-divisions, supplementing the maps of the geological survey.
- (b) Records of changes caused by frost, wind, rain and tides along our coast.
- (c) Records of the wasting of the banks of rivers, the variations in their channels, the rate of flow, the constantly changing nature and quantity of the sediments which they carry, the causes and effects of their spates and chemical compositions of their waters.
- (d) In the case of fossils the value of zoning as a key to stratigraphical problems was dwelt upon; as also the careful investigation of beds charged with special plant remains, fish and shell bands, algal layers and other horizon-fixing organisms.

A paper on "The Encouragement of Public Interest in Science by means of Popular Lectures" was read by Mr. Percival J. Ashton; and a paper by Mr. Arthur Bennett "On the Desirability of forming Federations of Societies with Cognate Aims."

Both papers gave rise to interesting discussions. It was evidently the opinion of the Conference that science must play an all important rôle in the future; and Scientific Societies should instil into the minds of the general public the need of sound scientific training and the application of scientific methods to all the ramifications of trade and industry.

List of Members.

Revised to 8th January, 1917.

* HONORARY MEMBERS. † PAST PRESIDENTS. O ORIGINAL MEMBERS.
A ASSOCIATE MEMBERS.

Members elected since August 1st in Italics.

Members resigned since September 30th, in brackets [.....].

The year of election is given before the name of each member.

A

1911 [Abbott, A. J.]
1912 Alabaster, Lady
1905 Alder, Mrs.
1908 Alder, Miss Evelyn
1908 [Aldridge, Mrs.] deceased
1913 Alexander, Saml. J.
1911 Allan, Alexr.
1911 Allen, Rev. F. A., M.A.
1906 Allis-Smith, Miss E.
1911 Allwood, Miss C. A.
1914 Andrews, W.
1912 Anstice, Mrs.
1914 Anthony, H. E.
1905 Archer, J. W.
1905 Archer, Mrs.
1913 Armstrong, Mrs.
1915 Arundel, John T., F.R.G.S.
1904 [Atkins, Dr. F.]
1904 [Atkins, Mrs.]
1911 Atkins, W.
1911 Atkins, Mrs.
1915 Atkins, Miss Bessie
1905 [Atkinson, Miss]
1916 *Austen, Mrs. B. Tennant*

Strathmore, 23, Westby Road, Boscombe
Dil Aram, 36, Sea Road, Boscombe
East Grove, Lymington

Denwood, 55, Alum Chine Road
Abbotslea, 5, Surrey Road
Bylands, Boscombe Cliff Road
Staffa, Wellington Road, Parkstone
Martello Towers, Branksome Park
The Chimes, 5, Crabton Close Road
Chineside, 15, Studland Road
Bryher, Tower Road
Rosendale, Branksome Wood Road
Windlesham, 5, Braidley Road

27, "Cecil Road, Boscombe
Savoy Hotel, Bournemouth
Cathay, 44, Alumhurst Road

The "Hermitage, 40, Wimborne Road

Glen Lee, "10, Alumdale Road
Berwyn, Ashley Road, New Milton
Athelstan, Queen's Park Road

B

1906 Backhouse, Hy., F.R.H.S.
1910 Bain, Mrs.
1910 [Bainbridge, Surgeon-General]
1914 Banfield, Col. R. J. F., C.B.
1905 Banks, R. Y.
1905 Barlow, E. W., B.Sc., F.R.A.S.
1915 Barnes, Oliver Geo.
1912 *Barraclough, Aug., M.A.*
(Cantab.), F.R.G.S.
1909 Barratt, J. Hayes
1914 Barrington, W. J.

1905 Bartlett, H. F. D., F.E.S.
1914 Bartlett, T. O.
1910 Beck, Rd., F.E.S.
1909 Benison, F.
1909 Benison, Mrs.
1905 Bennett, Miss E. C.

Yelland, 23, McKinley Road
14, Oxford Avenue, West Southbourne
Vernon, Sandecotes Road, Parkstone
Park View, 42, Poole Road
Egerton, 12, Portchester Road
32, New Park Road, West Southbourne
Glen Lee, 1, Suffolk Road
56, Richmond Wood Road
Brundon, 2, Surrey Road
Heather Dene, Penn Hill Avenue, Parkstone
1. Myrtle Road, Richmond Park
Wilts and Dorset Bank, Westbourne
Red Lodge, 49, Portchester Road
Aldborough House, 14, Rosemount Road
Bonavista, "19, Boscombe Spa" Road

- 1904 Bennett, H. Morden Manor Lodge, 20, Manor Road
 1916 ^ABenns, Miss R. L., HONS. B.A., High School, Norwich Avenue
 Lond.
 1916 Beyerhaus, Miss Minnie Westbourne High School, Pine Tree Glen
 1913 Bilton, Miss C. E. Dilkhush, 25, Parkwood Road, Boscombe
 1912 Blackall, Miss E. E. Leamfield, Castlemain Road, Stourwood
 1908 Blackett, C. H. Rosapenna, 16, McKinley Road
 1908 Blackett, W. Eggleston Blanchland, 21, McKinley Road
 1915 [Blackledge, Miss K., B.A.] Terra Firma, Cellars Farm Estate, South-
 bourne
 1915 Blondel, Mrs. Redroofs, Ipswich Road
 1916 Bloomfield, Rev. H., M.A. Moordown Vicarage
 1911 Blosse, Rev. R. C. Lynch Hawthorn Dene, 10, Cavendish Road
 1911 Blosse, Mrs.
 1910 ^{*}Bond, F. Bligh, F.R.I.B.A. 454, Gloucester Road, Bristol
 1916 Booth, Miss Boscombe Grange, Percy Road
 1914 Bradbury, Miss La Bocca, 2, Portarlington Road
 1914 Bradbury, Miss Alice
 1914 Bradbury, Miss Edith
 1908 Brazier, J. J.
 1914 Bright, Percy, F.E.S.
 1915 [Brown, John H.] Fairlawn, 48, Lowther Road
 1915 [Brown, Mrs.] 26, Portchester Road
 The Bluff, Canford Cliffs
 1915 Brownsworth, Miss Edith M. Stoneleigh, Heron Court Road
 1917 Brownsworth, Mrs. M. E. " " "
 Fowler
 1905 Brumell, Geo., A.R.I.B.A. Maori, Richmond Park Avenue
 1916 Bryant, Mrs. Wolverton, Alumhurst Road
 1907 Bulfin, Ignatius, B.A. The Den, 26, Knole Road
 1908 Bulfin, Mrs.
 1915 Burton, Jas. 163, Richmond Park Road
 1916 Byfield, Miss D. Fern Coombe 11, St. Stephen's Road

C

- 1910 Cameron, Miss Little Forest House, 19, Bath Road
 1913 Capper, Thos., M.A., B.Sc. Ropley, Stirling Road
 1912 Carus-Wilson, C., F.R.S., Edin., Altmere, Waldegrave Park, Strawberry
 F.G.S. Hill, Middlesex
 1909 Chandler, S. Whitty, B.A. and Royal Societies' Club, S.W.
 1906 [Chapman, F. F.] deceased St. George's, Cecil Road, Boscombe
 Penrhyn, Chessel Avenue, Boscombe
 Manor
 1909 Chapman, Miss
 1912 Charsley, Mrs.
 1912 ^AChilver, Miss Kathleen M. Camborne, Belle Vue Road, Southbourne
 1911 ^A[Chisman, Miss E. M.] 79, Richmond Park Road
 1911 Clark, Walter Child Heatherlea, 11, Cowper Road, Moordown
 1905 Coddington, E. F. Michelgrove House, Boscombe
 1911 Collins, W. F. St. Frideswide, 94, Southbourne Road
 1911 Compton, Rev. D. G. Vellore, Overcliff Drive
 1908 Cooke, F. I. The Downs, Clifton Road, Southbourne
 1912 Cooper, Ernest Corona, Annerley Road
 1909 Cooper, Mrs. J. Omer 100, Old Christchurch Road
 1909 Cooper, J. Omer 6, Queensland Road, Boscombe
 1910 [Cooper, Wilfrid Omer] killed in " " "
 action " " "
 1908 Cooper, Rev. W. H. Windle, The Birks, 2, Branksome Wood Road
 M.A., F.R.G.S.
 1910 Cooper-Dean, Mrs.
 1916 Corner, Rev. Arthur E. The Old Vicarage, Pokesdown
 Eversley, Branksome Avenue

1917	<i>Corrie, E. Rowland</i>	Coombe Wood, Balcombe Road, Branksome Park
1917	<i>Corrie, Mrs.</i>	
1914	Cotes, Sir Merton Russell, J.P., F.R.G.S., M.J.S.	East Cliff Hall " "
1914	Cotes, Lady, F.R.S.L., M.J.S.	" "
1913	Cotes, H. V. M.	Meyrick Park House, Meyrick Park
1916	<i>Cowell, Geo. Edmund</i>	Hawthorn's Hotel
1904	Cowie, Dr. C. G., M.A., M.D.	Bonaccord, Westminster Road
1903+	Crallan, Dr. G. E. J., M.A., M.B., M.R.C.S.	Gouray Lodge, Gorey, Jersey, Channel Islands
1915	[Crapper, H. Sugden, L.D.S., M.R.C.S., L.R.C.P.]	Fatshan, Parkstone Road, Poole
1905	Crespi, Dr.	Cooma, Poole Road, Wimborne
1912	Crowther, Miss Violet	Shelbrook, Brunstead Road, Westbourne
1916	<i>Crump, E. Compson</i>	The Hurst, Burton Road, Branksome Park
1916	<i>Crump, Mrs.</i>	
1913	Curme, Decimus, Surg. Lt.- Col.	Child Okeford, "Blandford" "
1913	Curme, Mrs.	
1903	oCurtis, W. Parkinson, F.E.S.	The Square "
1914	Curtis, Eustace H.	Aysgarth, Poole

D

1914	*Dale, Wm., F.S.A.	The Lawn, Archer's Road, Southampton
1909	[Davenport, Miss C.]	Torvaine, Parkstone
1910	de Castro, Geo., M.R.C.S. (Eng.)	Sunnydene, 76, Drummond Road
1910	de Castro, Mrs.	" "
1915	de Castro, Miss Mary B.	" "
1905	de Paiva, R. A.	San Remo, 13, Carysfort Road
1910	de Paiva, Mrs.	" "
1914	Dickson, Col. W. D.	Southill, 32, Dean Park Road
1914	Dickson, Mrs.	" "
1903o	*Dixon, Dr. J. R. L.	
1910	Dodshon, Edwin., L.L.B.	Lloyds Bank Chambers
1915	Dolby, Geo. Alex., F.R.G.S.	Nazdar Hall, Branksome Avenue
1904	Druitt, J., J.P.	Avebury, 10, Madeira Road
1913	[Druitt, Robt.] deceased	Carfax, Christchurch
1906	Dunning, Mrs.	The Homestead, 21, St. Clement's Road
1914	Dyer, J. Herbert	Hillcrest, Queen's Park West Drive

E

1904	Earle, Dr.	The Wyke, Brunstead Road
1912	[Edwards, Aubrey] deceased	The Pinetum, Wellington Road, Parkstone
1912	Eiloart, Miss	Glengyle, Chester Road, Branksome Park
1913	Ellis, Hy. J.	Chesterford, Richmond Park Avenue
1914	Else, Miss	Esterel, 31, West Cliff Road
1904	Elwes, Captain G. R., J.P.	Bossington, 14, Knyveton Road
1909	Evans, P. H. L., M.A.	Stirling House, Manor Road
1916	<i>Evans, Rev. L. H., M.A.</i>	Goodrest, Purbeck Road, Parkstone

F

1910	[Fairles, Gustavus W.]	Bank House, Alexandra Road, Parkstone
1916	<i>Farnell-Watson, Mrs.</i>	15, Alumdale Road
1914	Fielding, Dr. Thos., M.D.	Halford House, West Hill Road.

1903^oA Firbank, Miss, L.L.A., A.C.P.
 1905 [Fraser-Hird, Rev. F., M.A.]
 1914 [Fraser-Hird, Mrs.]
 1906 Frean, G. M.
 1910 Frean, Mrs.
 1915 Frean, Miss Eleanor
 1913 Freeman, Miss Emily
 1915 Freeman, Geo. Broke
 1909 French, J. M.
 1911 Frewin, Alfred
 1911 Furlong, R. O'B., C.B., M.A., J.P.
 1916 *Furner, Miss Kemp*

5, Buchanan Avenue
 Eaglehurst, 16, Parkwood Road
 " "
 Cranicombe, Branksome Avenue
 " "
 " "
 Corona, Annerley Road
 Hasland, 13, Grosvenor Road
 The Gables, 12, Wharncliffe Road
 Rowherne, 43, Branksome Wood Road
 Maesbury, 3, Cavendish Road
 Calluna, 4, West Cliff Road

G

1911 Gardiner, Miss F. M.
 1916 *Gaskell, Miss Edith M.*
 1913 George, Arthur Durancé
 1914 A Gill, Edwin R., A.R.C.A.
 1914 [Girdlestone, Miss Lucy]
 1911 [Gissing, Admiral C. E.]
 deceased
 1903 o Goodall, T. B., F.R.C.V.S., F.L.S.
 1914 Gosse, Wm., M.D., D.P.H.
 1916 *Grace, Geo., B.Sc., Lond.,*
 A.R.C.Sc.
 1917 *Grace, Mrs.*
 1909 Graham, F. A.
 1911 Grange, W. D'Oyly, M.D.
 1904 Gray, A.
 1911 Gray, Geo. W.
 1911 Gray, Mrs.
 1914 A Green, C. B.
 1914 Greves, E. Hyla, M.D., M.R.C.P.
 1914 Greves, Stanley S. Hyla
 1916 Grubb, Rev. H. P., M.A.

Heather Cottage, Talbot Hill, Winton
 St. George's, Darracott Road
 Alderholt, 6, Clarendon Road
 Public Library, Poole
 Ruabon, Richmond Park Crescent
 Homestead, Queen's Park South Drive
 Purewell Cross, Christchurch
 The Links, Sandecotes Road, Parkstone
 Gwynfa, 4, Suffolk Road South

21, "Beaulieu" "
 11, McKinley Road
 Woodville, 26, Melville Road, Winton
 Darena, 15, Wellington Road
 " "
 Linden Villa, Argyle Road, Swanage
 Rodney House, Poole Road
 " "
 Surrey Lodge, "Balmoral" Road, Parkstone

H

1914 Haig, W. S.
 1915 A Hall, Chancellor T. C.
 1910 [Hamilton, G. G., M.B., F.R.C.S.,
 F.R.H.S.] deceased
 1910 Hamilton, Mrs.
 1913 Hammer, Miss A. G.
 1913 Hannah, W. Rainsford
 1916 *Hannah, Mrs.*
 1908 A Harding, Miss
 1913 Harris, Miss K.
 1912 Harrison, Henry
 1914 Hartley, Dr. J.
 1914 Hartley, Mrs.
 1914 Hatton, Rev. C. O. S., B.A.
 (Camb.)
 1907 [Heaton, Guy, M.A.]
 1911 Henslow, Rev. Professor G.,
 M.A., F.L.S., F.G.S.
 1905 Heywood, Col. J. M., deceased
 1916 *Hill, Rev. Reginald J., M.A.*

Birchwood Cottage, Birchwood Road,
 Parkstone
 Wyngreen, 75, Maxwell Road, Winton
 Boscombe Place
 " "
 66, Lowther Road
 Stanmore, 49, Branksome Wood Road
 Alma "Road Council School"
 Trescott Grange, Harvey Road, Boscombe
 Southlea, Durley Road, West Cliff
 62, Portchester Road
 " "
 Hinton Admiral Vicarage, Christchurch
 St. David's, 51, West Cliff Road
 Danehurst, 40, Branksome Wood Road
 Sutherland Hall, South Cliff
 Cavendish House, 8, Christchurch Road

- 1909 Hill, S. McCalmont, D.C.L.
 1904 Hinton, Miss
 1913 Hippisley-Smith, Rev. A.
 1916 *Holgate, Mrs.*
 1910 Holmes, C. F.
 1909 Holmes, Mrs.
 1911 Holmes, Miss M. A.
 1911 Holmes, Miss S. C. M.
 1911 Homer, L. V. C.
 1911 Honeyman, G.
 1912 Honeyman, Mrs.
 1912 Honeyman, Miss M. W.
 1911 Hudson, F.
 1911 Hudson, Mrs.
 1916 *Humphreys, Mrs.*
 The Club, Boscombe
 Welcombe, 1, Argyll Road, Boscombe
 Knowlton House, 22, Surrey Road
 63, Paisley Road, W. Southbourne
 Brackenwood, 37, Southern Road, West Southbourne
 4, Beaufort Road, West Southbourne
 Carron, 54, Southcote Road
 Stormont, Milton Road
 Peñarol, Parkstone
 Danebury, Twynham Road, Southbourne

I

- 1905 Ibbett, F. W., M.A.
 1914 Instone, Thos.
 1914 Instone, Mrs.
 1914 Instone, Allan C.
 1914 Instone, Mrs. A. C.
 1915 [Isaacs, Charles] deceased
 Central Education Office, Yelverton Road
 31, Portchester Road
 Rosemount, Balcombe Road, Branksome Park

J

- 1912 James, Thos. Bath
 1912 James, Mrs.
 1912 James, Miss G. Gladys
 1911 Jeffery, T. J. P.
 1911 Jeffery, Miss Ruby
 1912 Jeffery, Miss E. S. M.
 1909 [Jennings, Miss C. E.]
 1916 *Jones, Miss M.*
 1917 Jones, Mrs. Tudor
 1908 ^aJones, W.
 1905 Jones, W.
 Trevenen, Howard Road
 Meldon, Ormonde Road
 Boscombe Grange, Percy Road
 Edenhurst, Sandbanks Road, Parkstone
 10, St. Stephen's Road
 The Cottage, King's Avenue, Parkstone
 Council School, Boscombe
 254, Old Christchurch Road

K

- 1910 Kay, A. J.
 1911 Kaye, J. E.
 1911 Keevil, W. C.
 1914 Kenrick, Archibald
 1914 Kenrick, Miss M.
 1912 Keogh, Duncan
 1912 Keogh, Mrs.
 1916 *Kersey, H. A.*
 1917 *Kidner, Hy.*, F.G.S.
 1913 Killick, H. F.
 1916 Kilner, Miss Ethel M.
 1912 Kirkby, Mrs.
 Winsgarth, 141, Lowther Road
 Tynedale, 38, Portchester Road
 Eglington, Kinson, Bournemouth
 Broom House, 37, West Cliff Road
 The Warren, 13, Richmond Wood Road
 166, Old Christchurch Road
 194, Shelborne Road
 Rawdon, 9, Marlborough Road
 The Cottage, 33, Hawkwood Road
 Inglewood, Richmond Park Avenue

L

- 1916 Lake, Miss Edith B.
 1910 Lattey, F.
 1916 [Lawson, Chas. F.]
 1916 [Lawson, Mrs.]
 1913 [Leigh, Miss]
 1906 *Le Jeune, Hy.
 1910 Lendrum, Miss A. M.
 1913 Letcher, Mark Jameson
 1913 Lewis, Miss Constance F.
 1905 *Liddiard, Jas. E., F.R.G.S.,
 M.N.G.S. (U.S.A.)
 1903o *Linton, Rev. E. F., M.A., F.L.S.
 1916 *Littlejohns, Engineer, Rear-
 Admiral, C.B.*
 1916 *Logan, Mrs.*
 1909 Lucas, Arthur
 1903 oLupton, Miss
 1909 Lyon, Claude
 1909 Lyon, Mrs.
- 82, Christchurch Road
 Alynby, 44, Stourcliffe Avenue, Stourwood
 Woodcroft, 1, Gervis Road
 " "
 Wood Lodge, Penn Hill Avenue, Park-
 stone
 55, Ashley Road, Upper Parkstone
 c/o Mr. de Paiva
 Gwestfa, 18, Richmond Wood Road
 6, St. John's Avenue, Boscombe
 Rodborough Grange, 66, West Cliff Road
 Edmondsham, Salisbury
 Harrow, Forest Road, Branksome Park
 36, Hamilton Road
 Croftmoor, 23, Dean Park Road
 Bolingbroke, Knole Road
 Shalimar, Wilderton Road, Branksome
 Park
 " " "

M

- 1911 Macalister, R., M.INST.C.E.
 1911 Macalister, Mrs.
 1916 MacDougall, Geo. Rogers
 1908 AMackay, Miss
 1912 Mackelvie, J. McIntosh
 1912 Mackelvie, Mrs.
 1912 Mackelvie, Miss Esther H.
 1912 Mackelvie, Miss Doris
 1913 Mackenzie, Ridley, M.D.
 1911 McBean, Miss J.
 1909 AMcBean, Miss S.
 1910 Mann, W. P., B.A.
 1911 [March, H. Colley, M.D., F.S.A.,
 M.R.S.A.I., F.A.I.] deceased
 1905 *Markwick, Col. E. E., C.B.,
 F.R.A.S.
 1913 Martin, Miss Florence G.
 1911 Martland, Dr. T.
 1916 Mason, Rev. A. L. A., M.A.
 1906 Mate, Ald. C. H., J.P.
 1914 Mate, Sidney J.
 1916 *Mather, Alfred*
 1916 *Mather, Mrs.*
 1904 [Maude, W. C., J.P.]
 1916 [Maude, Mrs.]
 1912 Maybery, Joseph, J.P.
 1912 [Maybery, Mrs.]
 1907 [Michell, Theo., M.INST.C.E.]
 deceased
 1911 Michell, Mrs.
 1916 *Middleton, Mrs.*
 1912 [Moon, Miss]
 1909 [Moon, P. G. G., F.C.S.]
- Somerled, 29, Meyrick Park Crescent
 " "
 Bracken Coombe, 30, Branksome Wood
 Road
 St. Andrew's School, Malmesbury Park
 Cliff Cottage, Boscombe Manor Park
 " "
 " "
 " "
 Heather Bank, Richmond Hill
 Inglenook, 29, Parkwood Road
 Froebelheim School, 47, Lowther Road
 38, Crabton Close Road
 Nethergrove, Portesham, Dorchester
 Headquarters, Irish Command, Park Gate,
 Dublin
 32, Southbourne Road
 Standish House, Fitzharris Avenue
 Kelsey, 8, Denewood Road
 Elim, 3, Surrey Road South
 10, Landseer Road
 Elstead, 8, Knyveton Road
 " "
 Brackenwood, Gervis Road
 Riversdale, 25, Surrey Road
 Langley Dene, 55, Wellington Road
 Merton, 54, Christchurch Road
 " "
 Birdlip, 44, Lansdowne Road
 c/o Mr. Maybery
 Savona, Alexandra Road, Parkstone

- 1913 Moore, F. W. Goathland, Tower Road, Branksome Park
 1908 [Moorhead, Dr., M.A., M.D., J.P.] Imperial Hotel
 deceased
 1908 *Morris, Sir Daniel, K.C.M.G., 14, Crabton Close Road
 J.P., M.A., F.L.S.
 1911 Morris, Lady
 1908 Moss, Miss The Grange, 52, Westby Road
 1915 Muncaster-Jones, Thos. Hillingdon, Brunstead Road
 1915 Muncaster-Jones, Mrs. " "
 1915 Muncaster-Jones, Miss " "

N

- 1903 oNeale, J., B.A. Clonenagh, Montagu Road
 1910 Neale, Mrs. " "
 1910 Neale, Miss D. Lingdale, 73, Lansdowne Road
 1912 Neave, Mrs. "
 1912 Neave, Miss "
 1905 Neve, Miss G. Merridale, 11, Westby Road
 1914 Nicholl, G. B. T., J.P. Santos, Capstone Road
 1914 Norton, John J. Ashton Court, Branksome Park
 1914 Norton, Mrs. " "

O

- 1910 Oke, A. W., B.A., LL.M., F.G.S., 32, Denmark Villas, Hove, Brighton
 F.S.A.
 1912 [Old, Robt. H.] 5, Westover Colonnade
 1913 Oliver, Mrs. E. Teviotdale, Milton Road
 1903 oOrd, Dr. W. T., F.G.S. Greensted, 14, Madeira Road

P

- 1911 Pain, Miss M. T. Membury, 52, Wellington Road
 1903 oPainter, Hubert, B.Sc., F.C.S. 29, Talbot Road, Winton
 1904 Painter, Mrs. " "
 1910 Pate, Rev. J. Spencer House, Constitution Hill, Park-
 stone
 1909 Pechell, Sir A Brooke, Bart. c/o Messrs. Holt and Co., 3, Whitehall
 Place, S.W.
 1915 Penrose, Dr. Francis Geo., M.D., Hawkley, 27, West Cliff Road
 F.R.C.P., F.Z.S.
 1916 Penrose, Mrs. " "
 1916 Penrose, Miss Frances " "
 1916 Penrose, Miss Marcia. " "
 1912 Pestell, Miss Engelberg, Surrey Road
 1911 Phillips, Mrs. 43, Alumhurst Road
 1912 Philpott, Mrs. c/o Miss Cheere, 58, Barkston Gardens,
 S. Kensington, S.W.5
 1914*[Pickard-Cambridge, Rev. O., Bloxworth Rectory, Wareham
 M.A., F.R.S.] deceased
 1914 Player, Mrs. Wm. Westfield, 3, Surrey Road
 1914 Pollock, Mrs. 43, Wellington Road
 1909 APovah, Edwin 68, Parkwood Road
 1914 Powell, M. Edenhope, Chessel Avenue, Boscombe
 Manor
 1909 Preston, Donald W. Bank Chambers, Yelverton Road
 1916 Preston, G. A. Chalfont, 44, Belle vue Road

- 1912 Price, Miss Annie N. Shelford Lodge, 19, Grand Avenue, West Southbourne.
 1911 Pullman, A. Seacroft, Cliff Drive, Southbourne
 1911 [Pyemont, Miss Rosa U.] 32, Hawkwood Road, Boscombe

R

- 1915 ^ARainer, A. J. 6, King's Park Road
 1916 *Rainier, Mrs. P.* Gardenhurst, Queen's Park Road
 1915 ^ARalph, E. W. Berwood, Spring Road
 1915 Ramsay, Miss Redroofs, Ipswich Road
 1912 Rankin, W. Munn, M.Sc. Municipal College, Lansdowne
 (Leeds), B.Sc. (Lond.)
 1916 *Rankin, Mrs. Munn* Stoneleigh, Heron Court Road
 1904 †Ransome, Dr. A., M.A., F.R.C.P. Sunnyside, 7, Dean Park Road
 1905 *Rayner, J. F., F.R.H.S. [F.R.S.] Swaythling, Southampton
 1913* [Reid, Clement, F.R.S., F.L.S., F.G.S.] deceased Milford-on-Sea
 1915 Richmond, Miss K. E. 7, Davenport, Surrey Road
 1914 Ritson, Mrs. Plas Pinwydd, 2, Durrant Road
 1916 *Roberts, Hy. Astley, B.A.* Shalvah, Wilfred Road, Boscombe Manor
 (Lond.)
 1916 Roberts, P. E., J.P. Northover, Dunbar Road, Talbot Woods
 1916 Roberts, Mrs. " " " " " "
 1916 Roberts, Miss " " " " " "
 1915 Roberts, V. C., B.A. 41, Parkwood Road
 1910 Robertson, Mrs. Struan, Alum Chine Road
 1916 *Robinson, Miss A. M.* Armadale, Balmoral Road, Parkstone
 1916 Rogers, Hy. 10, Inverleith Terrace, Edinburgh
 1910 *Rogers, Rev. Moyle Chetnole, 11, Grosvenor Road
 1905 Rogers-Barns, Miss Bevois Cottage, 25, King's Park Road
 1914 Rooke, Miss S. G. Norbury, 53, Paisley Road
 1903 oRooper, Miss C. Agnes Pen Selwood, 13, Gervis Road
 1914 *Roper, Miss Ida M., F.L.S. 4, Woodfield Road, Redland, Bristol
 1911 Ross, Rev. T. S. Lennox, 16, Foxholes Road, Southbourne
 1907 Ross, Col. W. H. Ambleside, 9, Dean Park Road
 1916 *Rothwell, Mrs.* Whytton, Penn Hill Avenue, Parkstone
 1913 Rowe, Mrs. R. Vidal Viwa, 9, McKinley Road
 1905 Rudkin, Miss F. Ivel Cottage, 25, Hamilton Road, Boscombe
 1912 Rumsby, Mrs. Ennisfall, Fitzharris Avenue, Charminster Park
 1916 Russell, Mrs. Woodheath, 21, Knyveton Road
 1906 Russell-Wright, Rev. T. 92, Richmond Park Road
 1912 Rutherford, R. C. South Dene, 1, Groveley Road
 1910 Rutter, G. H., M.B. Roxbury House, 22, Poole Road
 1916 *Ryley, S., Clement* The Square, Wimborne

S

- 1910 ^ASaunders, Hugh A., B.A., Brookfield House, Swanage
 F.R.G.S.
 1913 Saunders, Miss L. Metta Pine Cottage, Chester Road, Branksome Park
 1912 Scarlett, Miss A. Fermoy, St. Alban's Avenue
 1912 Scarlett, Miss K. " " "
 1912 Scarlett, Miss M. " " "
 1908 ^AScattergood, J. Alma Road Council School
 1914 Scholes, Denton Craigmoor, 7, Branksome Wood Road
 1915 Scholes, Mrs. " " "
 1904 Scott, J. H., M.E., M.I.M.C.E. Kirkby, Linwood Road, Charminster Park

- 1905 Scott, W. H., M.A.
 1916 ASeeviour, G. C., A.C.P., F.R.H.S.
 1914 Sharp, Chas.
 1903 oSherring, R. V., F.L.S.
 1907 Sherring, Miss O. L.
 1914 Sidgwick, Chas.
 1914 Sidgwick, Mrs. C.
 1915 Simcox, Miss Winifred
 1916 Simpson, Rev. E. J. Douglas,
 M.A.
 1914 [Smith, Miss Hope]
 1911 [Smith, Rev. Philip H.]
 1914 Smyth, Dr. W. Johnson, M.D.
 (Edin.)
 1912 Smythe, J. H. Ralph, J.P.
 1915 Smythe, Mrs.
 1916 *Smythe, Miss Kathleen Mary*
 1912 Solly, Rev. Hy. Shaen, M.A.
 1909 Spencer, J. F.
 1913 [Spencer-Bower, Mrs.]
 1917 *Stell, Miss Emily*
 1916 Stiff, Sydney Jas., B.Sc.
 1916 Stiff, Mrs. F. L.
 1916 Stiff, Miss F. A.
 1908 Stokes, R.
 1912 [Stuart, C. M.]
 1912 [Stuart, Mrs.]
 1912 [Stuart, Miss]
 1904 [Sutton, H.]
 1911 Swain, H. E.
 1906 Swallow, E.
 1916 Swayne, Francis Thos.
 1916 Swinney, A. J. G., M.E.,
 M.INST.M.M.
 1905 Sworn, Mrs.
 1913 Sykes, Mrs.
 1913 Sykes, Miss
 1916 Tarr, Miss M. K.
 1911 Tatchell, Leonard
 1915 Taylor, F. B., B.A.
 1916 *Taylor, Mrs.*
 1916 *Taylor, Miss Mary Angela*
 1916 *Taylor, Miss Mary Winifride*
 1915 Taylor, Jas.
 1912 Thomas, J.
 1903 oThomson, Dr. J. Roberts, M.D.,
 F.R.C.P., J.P.
 1911 Thomson, Mrs.
 1911 Thomson, Matthew
 1916 *Thoroton, Rev. L. E. W.*
 1911 Tickell, Miss S. M.
 1916 *Tottenham, Chas. Edwd.*
 1911 Towsey, Miss E. L.
 1912 Tunnard-Moore, T. C., J.P.
 1911 Turner, J. E.
 1914 Twemlow, Miss Emily E.
 Hendall, Westminster Road
 St. Peter's School House
 Milfield, Langdon Road, Parkstone
 Hallatrow, near Bristol
 Lindsay House, Lindsay Road, Branksome
 7, Alma Road, Winton
 Carlton Miniott, 8, Wellington Road
 Cliff House, Cliff Drive, Canford Cliffs
 Spinney Hill, 44a, Grosvenor Gardens,
 Boscombe
 Pirbright, West Cliff Gardens
 Willstead, 22, Cavendish Road
 " "
 " "
 Southcote, Alexandra Road, Parkstone
 Glenthorne, 73, Richmond Park Road
 Lea Royd, 48, Westby Road, Boscombe
 Gwynfa, 4, Suffolk Road South
 Nordon House, Corfe Castle
 " "
 " "
 Laverstock, Cliff Road, Boscombe
 Morlais, Milton Road
 " "
 " "
 Ravenshall, 2, Chine Crescent Road
 Sorrento, Studland Road
 Westridge, Sandbanks, Parkstone
 24, Stourcliffe Avenue, W. Southbourne
 117, Richmond Park Road
 Normandale, 63, Lansdowne Road
 Oak Lodge, Talbot Avenue
 " "
 T
 Sandsfoot, Chester Road, Branksome Park
 23, Arcade
 Thurgarton, 55, Grand Avenue
 " "
 " "
 " "
 61, Lansdowne Road
 c/o Bright's Stores
 Monkchester, 17, Manor Road
 " "
 " "
 Fircliff, 29, Studland Road
 Hill House, Canford Cliffs
 Pinewood, 56, Stourcliffe Avenue, West
 Southbourne
 Athelstan, Queen's Park Road
 Moseley, 20, Owls Road, Boscombe
 Dunedin, 2, Darracott Road, Boscombe
 Park
 Bramley, Surrey Road
 Devon Lodge, 83, Alumhurst Road

U

- 1912 Usherwood, Rev. Canon T. E., Bagdale, Parkstone.
M.A.

V

- 1913 Veale, Miss Alice G.
1910 Veale, Miss L. H.
1910 Veale, Miss Mary Christina
1912 Veale, Miss Bertha
1908 Vernon, Major A. H.
1916 [Vickers, Mrs. S. F.]
1909 Vipian, Miss Dora

- Kintyre, 16, King's Park Road
" "
Lexton, "Richmond Wood" Road
1, Carnarvon Crescent, Boscombe
82, Christchurch Road
5, McKinley Road

W

- 1916 Walby, Arthur Edwd.
1911 Waldron, Miss F.
1913 Wallace, Wm. G.
1912 Walter, Mrs. G. P.
1916 *Warmington, Rev. Edwd. J.*,
M.A.

- 1916 *Warmington, Miss Dorothy M.*

- 1909 Warr, Miss Ada
1905 Waters, A. W., F.L.S., F.G.S.
1906 Waters, Mrs.
1915 [Waters, Mrs. Robt. S.]
1912 Watts, Col. Sir Wm., K.C.B.
1914 Webber, A. E.
1909 Webster, Rev. T.
1906 Wells, H. B.
1913 Wetherell, Miss
1911 Whiting, Albert

- 1916 *Whyte, A. C.*
1916 *Whyte, Mrs.*
1916 *Whyte, Miss Mina C.*
1916 *Whyte, Miss Mary N.*
1912 [Wilkinson, Mrs.]

- 1913 Willes, W. A.
1914 [Willes, Dr. Wm.]
1915 Williams, Dr. C. E. Campbell

- 1915 Williams, Mrs.
1914 Wood, W. H.
1916 *Wood, Mrs.*
1916 [Wood, Mrs. Brindley]
1916 *A Woodhead, Miss G. R.*, B.Sc.
1905 Woodhouse, W. J., A.C.P.
1914 *A Woodhouse, Wm.*
1909 Woollacott, J. C.
1917 *Woodward, Chas. H.*

- Netherton, 2, Dean Park Road
Benvenuto, 15, Portarlington Road
Ashley Chambers, Ashley Road, Boscombe
Rusholme, St. Anthony's Road
Manoa, 5, Clarendon Road

- " "
Cottesmore, Pokesdown Hill
Alderley, 2, McKinley Road

- " "
Dalbury, 4, Knyveton Road
The Priory, 53, Branksome Wood Road
28, Tower Road, Boscombe
Devonia, 2, Chatsworth Road
Stalham, 16, Studland Road
Triana, 21, Harvey Road, Boscombe
Rozel, 7, Pinecliffe Avenue, West South-
bourne
Byberry, Roslin Road

- " "
" "
" "
Mon Repos, 36, Grosvenor Gardens, Bos-
combe

- Elmwood, Cranborne Road
Ringstead, Milton Road
Greystones, Marlborough Road, Canford
Cliffs

- " "
Arosa, Tower Road, Branksome Park

- " "
Stelvio, Nelson Road
High School, Norwich Avenue
35, Chatsworth Road, Malmesbury Park
Attleborough, 34, Wimborne Road
Solent View, Belle Vue Road, Southbourne
Kenistone, Richmond Park Crescent

Y

- 1908 Yates, R. P.

- Woodmanton, 35, Wellington Road

RULES OF THE Bournemouth Natural Science Society.

Amended October, 1914.

1.—The title of the Society shall be THE BOURNEMOUTH Title
NATURAL SCIENCE SOCIETY.

2.—The objects of the Society shall be the promotion of the study Objects
of Science in all its branches, by means of Lectures, Field Meetings,
the Reading and Discussion of Papers, and the formation of Sec-
tions of its members devoted to any particular branch of the Society's
work, or by any other means that the governing body of the Society
shall deem advisable.

3.—The Society shall encourage the making of reports on any
plant, animal, or object of interest, and where the Society may deem
it necessary, shall take such steps as may be advisable to secure any
such plant, animal, or object of interest from injury, extinction or
destruction.

4.—The Society shall consist of Ordinary, Life, Associate, and Members
Honorary Members.

5.—There shall be a Council of the Society consisting of the Hon. Council
Treasurer, one or more Secretaries, Honorary or otherwise, the Vice-
Presidents who have filled the office of President, the Hon. Librarian,
the Hon. Editor, the Chairmen of Sections and twelve elected Members.

The Council shall have the general management of the Society.
At all Meetings of the Council, five shall form a Quorum. The Council
shall elect their own Chairman and Deputy-Chairman for the Year,
and shall have power to fill up any vacancies in their number which
may occur from time to time. The Council shall have power to ap-
point Committees to deal with any business that may be delegated to
them.

The Chairman, or in his absence the Deputy Chairman, at all
Meetings of the Council shall have an original and a casting vote.

The Council shall have the control of the Funds of the Society.

6.—The Executive Officers of the Society shall consist of the Executive
Chairman and Deputy Chairman of Council, Hon. Treasurer, and one Officers
or more Secretaries, Honorary or otherwise.

7.—The Ordinary, Life, and Associate Members of the Society shall
be proposed by an existing Member, and seconded by another existing
Member, and notice shall be sent to one of the Secretaries of the
Society of the names and address of the nominee, and the names of the
proposer and seconder. Any such proposed new Member shall be voted
for at the next ensuing Council Meeting, and if two-thirds of the Coun-
cil present and voting shall vote for the proposed new member, such
candidate shall become a Member upon payment of the Annual Sub-
scription, and shall receive a card of membership (not transferable)
entitling him or her to attend the Meetings of the Society. Mem-
bers joining during August and September shall be given a card of
membership to September 30th of the following year.

8.—Ordinary Members shall pay an Annual Subscription of Ten Ordinary
Shillings, due on the first day of October in each Year. The Annual Members.
Subscription for Adult Members of the same family, not exceeding
four and residing in the same house, shall be Twenty Shillings, each
Member being elected in the usual manner and each receiving a card
of membership.

Life
Members

9.—The Subscription for Life Members shall be Five Guineas. Any Ordinary Member who shall have commuted his Subscription, as provided for in this Rule, shall become a Life Member, but shall not by reason thereof have any different rights from those of an Ordinary Member.

Associate
Members.

10.—Associate Members are those who by payment of an Annual Subscription of Two Shillings and Sixpence are entitled to attend all the General Meetings and Excursions of the Society. They also have the privilege of attending the Meetings and Excursions of one particular Section they may select at the time of their Election, or at the commencement of each Session, their choice being notified by them to the Hon. Treasurer. The following are entitled to become Associate Members on Election by the Council:—

- (a) Teachers in schools who are still engaged in the active duties of their profession.
- (b) Persons, who in the opinion of the Council, although unable to pay the fee for full membership, are by their acknowledged scientific tastes or attainments, likely to prove useful working Members of the Society.

On further payment of Two Shillings and Sixpence Associate Members are admitted to the Meetings and Excursions of all the Sections.

Associate Members shall have no power of voting on the affairs of the Society, or of holding office.

Honorary
Members

11.—Any person who is either distinguished in Science or has rendered any special service to the Society, may be elected an Hon. Member. Such Hon. Members shall be proposed and elected in the same way as Ordinary Members.

Visitors

12.—Any Visitors introduced by a Member or producing a Member's card, may be admitted to any Meeting or Excursion of the Society on entering their names and that of the introducing Member in the Society's Visitors' Book. Such privilege not to be granted more than twice to any one person in each Session.

On the recommendation of the Council or Committee authorised by it, Visitors to Bournemouth desirous of attending the Meetings or Excursions of the Society, may obtain a ticket of admission for the Winter or the Summer Meetings or Excursions at a charge of Seven Shillings and Sixpence. Application to be made to the Hon. Secretary for submission to the Council or Committee authorised by it.

13.—Any Members whose subscriptions are unpaid at the end of the financial year (September 30th), on notice to that effect in writing having been given to them by the Hon. Treasurer, shall be reported to the Council, who shall have the power of removing their names from the list of members.

14.—Resignations should be in writing, and addressed to one of the Hon. Secretaries, and until such are received by them, Members remain liable for their subscriptions.

15.—The power of expulsion of a Member from the Society for objectionable conduct shall be vested in a General Meeting of the Society, provided the Council has caused special notice to be given on the circular convening the Meeting, and that two-thirds of those present and voting agree thereto.

16.—The Council shall arrange all Lectures, Papers, Demonstrations and Exhibitions of Specimens, etc., both for the General and Sectional Meetings of the Society, and shall decide upon all General and Sectional Excursions.

17.—The Council shall have power to form any Section or Sub-Sections, to consist of not less than six Members, for the study of any special subject which the Council may deem within the scope of the Society's work. They shall annually appoint the Chairman of any such Section or Sub-Section on the nomination of that Section or Sub-Section.

A Section shall consist of those Members who attend in each year not less than three meetings of such Section.

The Chairman of each Section shall appoint a Secretary, who in addition to the ordinary secretarial duties shall keep a list of the Members of the Section.

18.—Each Sectional Chairman shall be responsible for the preparation and arrangement of each Sectional Meeting and Excursion, and shall submit details of the same to the Hon. Secretary for submission to the next ensuing Meeting of the Council. He shall submit accounts of costs incurred by him to the Hon. Treasurer, after each Meeting or Excursion, who shall lay the same before the Council at their next ensuing Meeting. At the first Meeting of each Section or Sub-Section in the Year, after the Annual Meeting, such Section or Sub-Section shall nominate its Chairman. Sectional Meetings

19.—A book for each Section shall be provided by the Secretaries to be kept at the Society's Room; each Chairman of Section, or his Secretary shall enter therein an account of each Meeting, with number of Members attending, and notes of any matters of interest observed or discussed. Such book to be presented at each Meeting of the Council. Every Chairman of Section shall report at each Meeting of the Council. Every Chairman of Section shall report as to the work of his section at the Annual Meeting of the Society.

20.—Any Members of the Council other than Ex-officio Members who shall have failed to attend half the Meetings of the Council held in any one year, provided that such non-attendance be not caused by illness or absence abroad, shall not be eligible for re-election, except by desire of the Members present at the Annual Meeting.

21.—The President need not necessarily be selected from Members of the Society, and shall be elected annually. He shall deliver an Address at as early a date in the Winter Session as can be arranged. The President

22.—Any Member of the Society who, in the opinion of the Council, shall have rendered distinguished service to Science or to the Society, shall be eligible for election as a Vice-President at the Annual Meeting, as long as he or she remains a Member of the Society. Vice-Presidents

23.—Each of the Vice-Presidents in rotation shall be requested to act as Chairman at the General Meetings of the Society.

24.—The Secretaries shall perform all the usual secretarial work; shall keep minutes of all Council Meetings, and the Annual Meeting, and a synopsis of all General Meetings. They shall cause a programme of each General Meeting to be sent to every Member seven days at least before each such Meeting. They shall make all preparations for carrying out all General Meetings and General Excursions, at which they shall receive from each Member his or her share of the day's expenses, and therefrom defray all costs of the Meeting. Any surplus of such collection shall go to the General Fund, and any deficit be defrayed out of that fund. They shall keep an account of all out-of-pocket expenses incurred in arranging Meetings and otherwise. They shall give notice of their election to all new members, they shall furnish a copy of the Annual Report to all Members who have paid their subscription, to Honorary Members, and to any such Scientific Societies as the Council may from time to time appoint to receive them. Secretaries

Treasurer

25.—The Honorary Treasurer shall have the custody of the General Funds of the Society. He shall prepare a Financial Statement at the end of each Financial Year to be presented to the Council at the Meeting next preceding the Annual Meeting. He shall receive and acknowledge all Subscriptions, and shall issue tickets of Membership to all persons who are duly elected and have paid their Subscriptions. He shall bring before the Council any accounts that are due for payment. After presentation of the Balance Sheet to the Council, he shall submit it to the Auditors and lastly to the Annual Meeting of the Society.

26.—At the Annual Meeting and at all General Meetings of the Society, not less than ten Members shall form a quorum.

Annual
Meeting

27.—At the Annual Meeting, which shall be held in the month of October, the President, the Executive Officers (except the Chairman and Deputy Chairman of the Council), the Hon. Librarian, Hon. Editor, twelve Members of Council and two Auditors for the ensuing year shall be elected (either Auditor having the power to audit the accounts in the unavoidable absence of the other). At this Meeting the Council's Report of the past year, together with those of the Chairmen of Sections, and the Hon. Treasurer's statement of accounts, duly signed by the Auditors, shall be submitted.

28.—Alteration in the Rules shall be sanctioned by a majority of not less than two-thirds of the Members present and voting at the Annual Meeting, or at a Special Meeting called for that purpose, and no alterations shall otherwise be made.

29.—Notice convening an Annual or Special Meeting, together with any proposed alterations in the Rules, shall be given to Members at least seven clear days before such Meeting be held. Notice of General Meetings, and Council Meetings (if possible) shall be given at least seven clear days beforehand.

30.—On a written requisition, signed by at least five Members of the Society, the Council shall call a Special Meeting to consider any question as to the affairs of the Society, such Meeting to be called within three weeks of the receipt of the requisition, and at least seven days' notice shall be given to the Members. At such Meeting no other business than that mentioned on the requisition, and on the notice convening such Meeting, shall be considered.



Presidential Address

*Delivered at the Inaugural Meeting of the Session 1915-16, held at
Trinity Hall, November 13th, 1915, by*

SIR DANIEL MORRIS, K.C.M.G., J.P., M.A., D.Sc., D.C.L., F.L.S.

Hardy British Trees.

IN my first Presidential address I selected as my subject "The Mission of the Natural Science Society in promoting knowledge and research." In my second I discussed "Science and the War." In my present address I propose to offer for acceptance a summary of the results of investigations made during the last five years into the occurrence of hardy trees with remarks as to their origin, size, age, comparative rarity and historical associations. I am not without hope that what I have brought together in this connection may prove generally interesting and tend to encourage further research and observation in a very interesting branch of natural science. The present appears favourable for a careful study of trees. In the first place several valuable books have been recently published on hardy British trees; and secondly, owing to the considerable attention devoted to arboriculture in this country during the last two centuries we are in an exceptionally favourable position to study both broad-leaved trees and conifers that have been brought together from all parts of the world. Fortunately, it has been the fashion among our wealthy landowners to plant rare ornamental and other trees on their estates, and it is largely owing to this that an intelligent taste for arboriculture has been gradually established in these islands. It is generally recognised that the charming characteristics of English parks and pleasure grounds are not surpassed by those of any other country. It is also worthy of consideration that there are numerous introduced trees suited to our climate capable of being rendered of considerable value for forestry purposes. So that in addition to the keen pleasure to be derived from the study of trees and admiration of their varied and quiet grandeur there is the possibility in some districts of growing timber as a crop for profit. This neighbourhood affords exceptional opportunities for the study of trees. Bournemouth itself owes much of its beauty and health-giving qualities to the beneficial influences of its pine woods, while the extensive arboreal vegetation to be found in the New Forest, and in the extensive parks and woodlands within a radius of twenty or twenty-five miles of Bournemouth, render the district of peculiar interest to lovers of trees.

Oak.

It is only fitting in a review of trees to begin with the oak, which stands pre-eminent for its size and endurance. It "shows a thousand rings of spring in every bole." It is generally accepted

there are two well-marked species of oaks native of the British Isles.

What is known as the pedunculate oak has two small auricles at the base of the leaf, the stalk of the acorns vary from one to six inches long. This is the oak that usually bears huge trunks. It is claimed that all the famous oaks of history are of this species. It is the common oak of Hampshire, and remarkably fine specimens are to be seen in the New Forest and in some parts of Dorset. Notwithstanding introductions from other countries, the oak is still the monarch of our forests, and in the days when foreign timber will have become scarcer and dearer there is no doubt the oak will again come to its own. With the possible exception of the yew, no other of our native trees can compare with the oak as regards size and longevity. Its maximum duration of life is probably not less than one thousand years.

In the sessile oak (also known as the Durmast or white oak) the leaves have a long stalk or petiole, but the acorns are inserted on the branches and not stalked as in the pedunculate oak. Further, it comes into flower and leaf later by some days than the other species, and it is said to be less liable to the attacks of the roller moth. As corroborating this the Hon. Gerald Lascelles, late deputy-surveyor of the New Forest, says that he has seen the Durmast or sessile oak "standing out in brilliant foliage when, owing to the attacks of the moth, every other oak in the wood around was as bare of leaf as in winter." There is a difference of opinion as to the relative merit of the timber of the pedunculate and sessile oaks. Laslett, a recognised authority, says that, though he agrees generally with the opinion once prevalent that the timber of the sessile or Durmast oak was slightly inferior, he felt bound to admit that during a long experience in working the timber of both oaks he had not been able to discover any important difference between them. Owing to the application of iron to shipbuilding and architecture the oak has lost some of its former importance, but the timber has no rival for dignity and durability, and very few equals in beauty for domestic architecture and public buildings.

There are several very interesting old oaks to be found in the New Forest. In about 1860 Wise gave the measurements of the celebrated Knightswood oak as 17ft. 4in. in girth, the Western oak at Boldrewood as 24ft. 9in. in girth, but he added that the handsomest oak in the district was the Moyle's Court oak standing a few yards outside the forest boundary, which measured 18ft. 8½in. Mr. Heywood Sumner, F.S.A., has informed me that he measured the Moyle's Court oak in 1909, and he found its girth at 4ft. from the ground to be 20ft. 4in., while the longest lateral spread of branch was 55ft. from the trunk.

Gilpin, the author of one of the most charming books on the New Forest, alludes to three remarkable oaks that formerly existed in the forest. The first was known as the Rufus oak which grew on the spot where the Rufus Stone now stands. This tree

was seen by John, Lord Delamore; but it has long since disappeared. The "Groaning Oak" at Baddesley, about two miles from Lymington, continued an object of great curiosity "for a space of eighteen or twenty months, owing to the groaning noises that issued from it. In the hope of discovering the cause of the unusual sounds the owner bored a hole into the trunk." After that, as Gilpin quaintly remarks, "the tree never groaned." The Cadenham oak was remarkable because it produced buds and leaves every year in the depth of winter. Gilpin himself saw it in 1781. Afterwards leaves were sent to him on January 5th, 1782; these were fairly expanded and about an inch long. A lady who visited the tree in 1786 found fresh sprouted leaves an inch and a half long. The production of winter foliage in the Cadenham oak is similar to what commonly takes place in the well-known Glastonbury thorn; in the latter, both leaves and flowers appear in moderate quantities in mid-winter. They are not so abundant as in May, but they are said to possess the true hawthorn fragrance. I understand it is possible that the Cadenham oak or one of its descendants may still exist. It would be interesting to verify this.

It is stated that there are few, if any, oaks now living in the New Forest, which are remarkable for their size, as compared with the old trees mentioned above.

Among other interesting oak trees in the district may be mentioned the Mountjoy oak at Canford Manor. This noble veteran is still 60ft. in height, with a girth of 17ft. A quaint legend is associated with this tree, for which I am indebted to the agent, Mr. T. J. Meaby. The story is, that Lady Mountjoy, who lived at Canford Manor about the middle of the 15th century, was a cripple, and she asked her husband to grant her some land on which to build almshouses. Lord Mountjoy, in the rough fashion of those days, told her that she could have as much land as she could crawl around. She thereupon crawled on her hands and knees from the Manor House round the great oak and back again. The result, according to the legend, was the erection of the almshouses at Wimborne, which survive to this day.

A very handsome oak at Charborough Park is 87ft. in height, with a girth of 14ft. 2in. This has a clean stem up to 50ft., and has a fine head. At Melbury Park, Dorset, there is an extraordinary oak, known as Billy Wilkins' oak, which swells into an immense burry trunk 38ft. in girth. This is said to be 700 or 800 years old, and perhaps the largest in England.

At Rockingham Park, in North Hants, there are what are known as "brown oaks," yielding exceptionally valuable timber. Five of these were recently sold for £100 each. Elwes says that "brown oak, when the timber is of good colour, is superior to any other for the interior decoration of houses, and for making sideboards and other heavy furniture. Bog oak that has been buried for centuries in peat bogs is used for furniture, picture frames and small ornamental work.

A well-marked variety of the common oak is the Cypress oak, in which the branches point upwards. It has all the appearance of a well-grown Lombardy poplar. A tree of this at Melbury Park, near Dorchester, measures 65ft. in height with a girth of 3ft. 8in. Both in foliage and fruit it does not differ in any way from the ordinary oak. There is a purple leaved oak, a bronze leaved oak, and several with variegated leaves—white, yellow, and pink.

Pliny (A.D. 23-79) describes in detail the religious honour paid to the oak in Britain, and asserts that the Druids, as children of the oak, were so called from the Greek name for that tree. He says that the Druids held that the mistletoe was the most sacred plant provided it grew upon an oak—which it did very rarely. Although Mr. Elwes gives a list of twenty-three oaks in England reputed as bearing mistletoe, he was only able to verify two of them by personal inspection. The finest mistletoe oaks were shown him by Sir George Cornwall at Bredwardine, in Herefordshire in 1902. Mistletoe was growing on this in no less than fifteen different places. The occurrence of a mistletoe on an oak at Hackwood Park, south of Basingstoke, was published in the "Leisure Hour" in 1873. By the kindness of the Rev. G. Sampson, of Ramsdell Vicarage, photographs of three growths of mistletoe on oaks at Hackwood Park have lately been communicated to me. Miss Ida M. Roper, F.L.S., discovered a magnificent bunch of mistletoe on an oak, in Leigh Wood, facing the gorge at Clifton, near Bristol, in 1915. The mistletoe's favourite trees are black poplars. At Charborough Park a common maple was recently seen covered with mistletoe. Mistletoe also occurs on limes, apple trees (rarely on pear trees), walnuts, horse-chestnuts, elms, willows, medlars, and almond trees. Mr. Backhouse informs me he has seen mistletoe on a Scotch fir in Switzerland. It has also been reported on Corsican pine.

The Holm oak or *Ilex* is regarded as one of the finest of our evergreen trees. Its foliage is most abundant and its branches form heavy masses on the tree. It is native of Southern Europe, and was brought to this country about the sixteenth century. It is one of the most familiar trees along the South Coast and thrives well near the sea, where it usually forms a dense flat-headed bush. Inland it forms more erect and handsomer trees. Mr. Bean mentions its one defect as a tree in a trim garden, viz., that it sheds its leaves of the previous year in May and June, making an unsightly litter day by day. One way of avoiding this, he suggests, would be to plant the ground underneath with ivy amongst which the leaves fall and automatically disappear. There is a fine avenue of the evergreen oak leading from the main entrance of Highcliffe Castle to Highcliffe Church. In the grounds of the Castle are distributed some of the finest *Ilex* trees in the country.

Very closely allied to the *Ilex* is the Cork oak. This produces the cork of commerce and is occasionally grown as a curiosity in the southern counties. The largest tree I have seen of this was at

Stout Hall, in Gower, Glamorgan. This had a girth of about 15ft., and an estimated height of 50ft. It was in excellent health in August of 1916.

The Turkey oak, another native of Southern Europe, grows to a large size and is very ornamental. There are several moderately large specimens in the public gardens here. What is known as the Lucombe oak is supposed to be a hybrid between the Cork oak and the Turkey oak. It was raised about 1765 in a nursery at Exeter. A distinctive seedling of the Lucombe oak is known as the Fulham oak. Of American oaks quite a large number have been introduced. The most ornamental of these are the Scarlet oak and the Red oak. The latter is said to be the best grower among the American species in this country; its leaves turn in autumn to a reddish or yellowish brown. It differs from the Scarlet oak in that it has larger leaves, usually not so deeply lobed, dull beneath and not so bright above. In the Scarlet oak the leaves are of a brilliant red and they produce one of the richest of autumnal effects.

Beech.

Among British trees the Beech excels in grace, vigour and hardihood. Its remains have been identified in the post-tertiary beds at Southampton. This disproves Julius Caesar's assurance that the "fagus" did not grow in Britain. Although not a native of Scotland, Sir Herbert Maxwell claims that "it is in Scotland that the mightiest beech in the United Kingdom, perhaps in the world, is to be seen." He is careful to say not the loftiest (although it measures 100ft.), but as containing the largest amount of timber. This is the famous tree at Newbattle Abbey, near Dalkeith. Mr. Elwes took its dimensions in 1906 and found it to girth 20ft. 3½in. at 5ft. The beech is not long-lived compared with the oak—probably not exceeding 200 years. Mr. Elwes, however, estimates the age of the Newbattle beech at 300 years. This is due to the fact that it has prolonged its existence by allowing branches to droop to the ground, where they have taken root and sprung up afresh and formed a perfect grove still maintaining connection with the parent tree. A similar instance of self-layering in a beech tree occurred at Kew. In the New Forest two large beeches are mentioned by Wise, viz., the Studley beech with a girth of 21ft., and the Holmy Ridge beech with a girth of 20ft. Mr. Elwes furnishes the following interesting summary of other notable beech trees in the forest. He says: "In Hants there are many fine beeches in the New Forest, of which the wood called Mark Ash contains some of the most picturesque, and is to my eyes one of the most beautiful woods from a naturalist's point of view in England, or even in Europe, though it is, like so many of the fine old woods in the New Forest deteriorating from causes which are described elsewhere. One of the finest trees here is over 100ft. high and 24ft. in girth, dividing at about 10ft. into six immense erect limbs, and entirely surrounded, as are many of the trees in this wood, by a dense thicket of holly. There is another

beech at Woodfidley in the New Forest which Mr. Lascelles considers the finest beech in the forest, and of which the measurements as given by him are 120ft. high, 14ft. 6in. in girth at 5ft., carrying its girth well up, with an estimated cubic content of 650ft. In old Burley enclosure is another magnificent beech, rather shut in by other trees, and therefore difficult to measure for height. I estimated it at 110ft. high. The girth was 18ft., dividing at about 25ft. into two main trunks, which carried a girth perhaps 8ft. up to a great height. I have no doubt this tree contains 700ft. to 800ft. of timber."

From Ashton Court near Bristol I have received from Mr. Napier a photograph of a splendid beech 130ft. in height with a girth of 16ft. at 5ft. There is a fine beech at Charborough Park, which measures 69ft. in height with a girth of 15ft. Another at Canford Manor is 90ft. in height with a girth of 14ft. 8in. At Heron Court there is a group of beeches planted in 1806. They have not attained large dimensions, probably owing to the dry gravelly soil. Among the decorative varieties of the common beech are the well-known Copper and Purple beeches. The copper is probably a seedling variety from the purple beech. The leaves are paler and of a coppery red. The purple is by far the more popular variety. A fine copper beech grows at Wrackelford, near Dorchester, the property of Mr. Alfred Pope. It measures 10ft. 3in. in girth. An upright beech, similar to the Lombardy poplar, is known as the Dawyck beech. The Fern-leaved beech makes a fine shapely tree and is a distinct ornament in any garden. There are also weeping beeches. In some forms of these the whole tree is of an umbrella-like shape.

Elm.

It is somewhat difficult to distinguish between the different elms owing to the large number of varieties and natural hybrids. At one time the leading botanists recognised only two true species—the English elm and the Wych elm.

In the recently published monumental work, "The Trees of Great Britain," by Elwes and Henry, there are carefully described five native species and about thirty varieties. The elm with which we are most familiar in this neighbourhood is the Common or English elm, a native of Southern England. It is found in woods and hedges, especially in districts with fairly stiff soils. The fertile valleys both in Hampshire and Dorset are said to be full of big elm trees.

Gloucestershire holds the record for the tallest elms. The largest true English elm in Hants, recorded in 1887, was at Broadlands, near Romsey. This was 100ft. high, with a girth of 24ft. 6in. At Canford Manor, a fine elm, near the Nineveh Court, is 110ft. high with a girth of 17ft. 4in.

At Charborough Park there is a still taller tree measuring 115ft. with a girth of 20ft. Further west at Melbury Park there is a row of seven large elms known as the Seven Sisters, stand-

ing in front of the house. The noble tree in the centre in 1906 measured 130ft., with a girth of 17ft. 10in.

The Wych elm is widely distributed throughout Ireland and Scotland, and occurs in coppices and woods on hilly ground in most parts of England. It can easily be distinguished from the common elm by the fact that it throws up no suckers from the roots, and by the very short, stout, densely-hairy stalk to the leaves. It regularly produces abundant seed. There is a weeping Wych elm, much planted as an ornamental tree. There are also weeping hybrids, such as the Huntingdon elm, the Dutch elm, and the Downton elm. In the King's Park Road (running parallel to the Boscombe Cemetery) and in the Grand Avenue at Southbourne there are very promising young trees of a variety of the Cornish elm. This is probably the variety *Wheatleyi*, which is described by Mr. Bean as admirably suited for street planting, as it retains without artificial aid the slender tapering form essential for beauty and symmetry in all avenue trees. A large tree of Wych elm growing by the dairy at Wrackelford, Dorset, measures 14ft. in girth.

Ash.

Although the ash is common in woodlands on chalk in association with the pedunculate oak and the beech, also on some clay formations, large trees are not generally met with in this district. Where planted and placed under favourable conditions the ash flourishes with great vigour. One of the largest ash trees I have met with is in a dell at Merly House, near Wimborne. Its girth is 19ft. 6in. As it has been pollarded at 10ft. its height is not considerable. The tallest ash measured by Mr. Elwes in 1907 stood 146ft. high and was 12ft. 7in. in girth at 5ft. This noble tree was growing at Cobham, in Kent. Sir Herbert Maxwell claims that there is no broad-leaved or hard-wood tree that can be so profitably cultivated as the ash. The properties which ensure this are its "hardihood, the matchless quality of its timber for many purposes, and its market value from an early age." The Scots hold the ash in special favour inasmuch as it furnished staves for their national weapon, the pike. For gardens there is a Golden Bark ash and a weeping variety of the same. Also a curious one-leaved ash (*F. monophylla*). The best of the introduced species of ash is the Manna ash (*Fraxinus Ornus*) which is specially desirable for ornamental planting. It produces a profusion of creamy white plumes of blossom in June. A moderately large tree of this was lately seen at Merly House.

Poplar.

There are three species of poplars native of Britain. Tennyson's verse—

"Hard by a poplar shook alway,
All silver green with gnarled bark,
For leagues no other tree did mark
The level waste, the rounding gray"

no doubt applies to the grey or Abele poplar (*Populus canescens*). The other native species are the Aspen (*P. tremula*) and the Black Poplar (*P. nigra*). What are known as the Balsam Poplars are easily recognised by their very gummy winter buds and leaves, which emit a pleasant balsamic odour when expanding in spring. The Asps or Aspens have long laterally-flattened leaf stalks, and are noted for the restless movements of their leaves.

Of all known species of poplars, thirty or so in number, the Abele or Grey poplar (*canescens*) produces the choicest timber, much in request by carriage builders, who sometimes pay as much as 2s. 6d. a cubic foot for well-grown logs. Next in economic importance is the Black Italian Poplar, which is said to produce valuable timber, in great bulk, in a shorter term of years, than any other British grown tree. Mr. Elwes, a great authority on such matters, has recorded how thirty poplars of this variety planted on cold clay in Gloucestershire, not worth 5s. an acre, were sold for £3 apiece, at forty-eight years of age.

There is a very interesting avenue of the Black Italian Poplar on each side of the private carriage drive from the Throop Road to Heron Court. I have been kindly supplied by Mr. P. Trentham Maw with a few particulars: "The trees are planted in rows running north and south, and they may be looked upon as well grown forest trees. There are fifty-nine trees in all; the average height is 115ft. The highest is 125ft. The age, from planting, is forty-nine years. The estimated yield of timber, say in fifty years, would be at the rate of 6,200 cubic feet per acre. This shows an annual increment at the rate of 124 cubic feet under bark. The soil is good alluvial loam with plenty of moisture, but not in any way sour." Mr. Maw noticed that the trees on the eastern side of the avenue exhibited growth 13 per cent. greater than those on the western side. In view of the fact that the economic importance of the Black Italian Poplar has not been fully realised in this country, the figures given by Mr. Maw, supported as they are by what is stated above by Mr. Elwes, are of considerable value to estate owners.

The true Black Poplar is distinguished by "the large burrs on the stem, by its earlier leafing and by the young foliage being green instead of reddish as in the Black Italian Poplar." As a timber-producing tree the Black Poplar is not equal to those mentioned above, but as a tree for parks and gardens Mr. Bean says it has many advantages.

The well-known Lombardy Poplar, "the most valuable of all fastigiate trees, differs from the Black Poplar only by its slender form and quite erect branches." Nearly all the Lombardy Poplars in cultivation are males, but a few female trees are known. The latter are not so slender as the male, and as they litter the ground with their cottony tufts at seeding time they are much less desirable. The first Lombardy Poplar was introduced to England in 1758. The tallest specimens attain a height of 100ft. to 125ft.

It may be mentioned that there is an attractive variety of the White Poplar (*Bolleana*) with erect branches closely resembling the Lombardy Poplar. There is a fine specimen of this, 67ft. high, near the large Ginkgo tree at Kew. There are a few specimens in the Upper Valley Gardens at Bournemouth. According to Dr. Henry, there is also an erect variety of the Black Italian Poplar in cultivation on the Continent. By courtesy of Lord Egmont, I have seen some fine Black Poplars flourishing on the other side of the river, near Avon Castle. The girth of the largest is 12ft. There are also a few Grey or Abele Poplars.

Willows.

It is related that a certain botanist of distinction being consulted by an amateur about some variety of willow exclaimed: "Pray, don't tempt me among the willows; that way lies madness." There are about sixteen recognised British species, besides an infinite number of hybrids. I will only attempt to speak of a few of the commoner willows that are of most value for their timber. There is no doubt that what is known as the Blue Willow (*Salix cærulea*) is in greatest demand as it produces the only wood suitable for first-class cricket bats. It is supposed to be a hybrid between the White Willow and the Crack Willow (*fragilis*). The Blue Willow originated in the eastern countries and most of the supplies of timber are still drawn from that area. Almost fabulous prices are recorded to have been paid in some instances. Elwes states that in January, 1912, eleven Blue Willows were sold in Hertfordshire at fourteen years of age for £81, or about 13s. per cubic foot. In 1888 a Blue Willow at Boreham, in Essex, measuring 101ft. high, with a girth of 16ft. 3in., yielded timber sufficient for 1179 cricket bats. From the same estate another Blue Willow was sold in 1911 for £70. The White Willow (*S. alba*), more commonly known as the Huntingdon Willow, also supplies a rapid return of light, tough wood, suitable for flooring and cart and waggon bodies. Some kinds of willows are cultivated along the river margins for osiers for basket making. Then there is the well-known Weeping Willow (*Salix babylonica*). This is supposed to have been brought to England in 1730 from the Euphrates Valley and planted at Twickenham Park. A great impetus was given to its cultivation through the introduction from St. Helena of Weeping Willows raised from a tree in that island under which Napoleon was buried. Several fine specimens, descendants of this tree, are to be met with at Kew and on the banks of the Thames; some of them are 50ft. or 60ft. in height.

Sycamores and Maples.

Continuing our review of naturalised or British trees we come to another interesting group. The sycamore is said to have a life period probably three times that of the beech, and almost equal to that of the oak. It is a native of Central and Southern Europe, but flourishes, exceedingly, in many parts of Britain.

It is a peculiarly hardy tree and one of the few that will stand the full force of sand-laden winds along the coast. It may be battered and stunted in growth, but it readily helps to form a first line of defence in seaside planting. On the other hand Sir Herbert Maxwell declares that in favourable situations it rapidly establishes itself by seed and produce timber, "when of sufficient size, that commands a higher price than any other British grown wood." That size must be not less than 18in. quarter-girth. It is chiefly in demand for making large rollers used in calico and wall-paper printing. The tree is rare on heath-lands in this district, but fairly plentiful elsewhere. There are many beautiful varieties, some with leaves striped with white and yellow, yellowish pink and purple, others of a rich yellow with the leaf stalks reddish.

The Norway Maple has its leaves green on both sides, and the stalks exude a milky sap when broken. It is thus readily distinguished from the sycamore. It is one of the handsomest, hardiest and most vigorous of our introduced trees. There are more than twenty named varieties.

The Common or Field Maple occurs frequently in hedges and thickets, especially on chalk. It does not usually form large trees. The wood, which is hard and of a fine grain, was formerly in great demand for furniture purposes. As of local interest it may be mentioned that when the Rev. William Gilpin died in 1804 he was buried at the foot of an English Maple growing in his own churchyard at Boldre, near Lymington. Strutt gave a figure of this tree, which he described as the largest of the species in England. Its measurements were 45ft. in height, with a girth of 7ft. 6in. I have recently visited this tree, which has lost its top and is evidently in a decaying condition. Its present height is only about 25ft. The girth is still 7ft. 6in., but the stem is matted with ivy. Numerous common Maple trees of large size have been recorded by Elwes and others. A tree at Hursley Park, Hants, the property of Sir George Cooper, Bart., was considered by Sir Joseph Hooker to be the finest he had ever seen. It was 9ft. 6in. in girth, with ten large spreading limbs and contained 111 cubic feet of measurable timber. Another fine Maple about 75ft. in height is mentioned as growing at Cobham Hall, in Kent.

Horse Chestnut.

This is one of the best known and most attractive of our large flowering trees. Its native country is the uninhabited wilds of Northern Greece and Albania. It thrives most vigorously in almost every part of the British Isles, and there are fine avenues and groups of horse chestnuts to be met with. For instance, the splendid double avenue at Bushey Park, near Hampton Court, has long been famous. "Chestnut Sunday" is a noted festival for Londoners when the trees are in full bloom.

I have seen near Wimborne a very fine horse chestnut measuring 80ft. in height, with a girth of 12ft. 10in. There is also a

large horse chestnut tree on the lawn at Hinton Admiral, the residence of Sir George Meyrick. This is about 60ft. high, with a girth of 7ft. 8in. One of its larger branches, about 27ft. from the bole and resting on the ground, has taken root and sent up a separate stem about 20ft. high. There are six handsome horse chestnuts to be seen in the Avenues at Dorchester, varying in girth from 12ft. 9in. to 10ft. 6in. These were planted in 1740. The Indian Horse Chestnut (*Æ. Indica*) is described as "one of the most magnificent of all temperate trees." It is perfectly hardy, and flowers about a month later than the common tree—a great point in its favour.

Sweet or Spanish Chestnut.

This is not a native of the British Isles, but of South Europe, North Africa, and Asia Minor. It is supposed to have been introduced by the Romans, and it certainly existed here before the Norman Conquest. Except possibly the sycamore, no foreign tree has more fully adapted itself to our conditions. Shakespeare was quite familiar with the tree and its fruit. The latter has been long enough established in England to have its name borrowed to denote a rich shade of russet. The stem of the chestnut tree often shows a characteristic twisting unlike any other tree. The timber of the chestnut, when fully ripe, is declared by Sir Herbert Maxwell to be fully equal to that of the oak, but it has one defect, viz., its liability to split along the annual rings. As a coppice tree, the chestnut has no equal, and amongst other uses it supplies material for an admirable fence for palings bound with wire.

Perhaps the oldest chestnut tree in the country is the celebrated Tortworth Chestnut. It is now a ruin, but a magnificent, and by no means a lifeless, one. According to Mr. Bean, it measures about 50ft. in the narrowest girth, equal to about 5½ yards in average diameter. According to legend, King John held council under it, and even in King Stephen's reign Evelyn says it was known as the Great Chestnut of Tortworth.

In our immediate neighbourhood there is quite a remarkable chestnut tree. In an account of Great Canford, the seat of the Earl of Wimborne, Hutchins, in his History of Dorset (written about the beginning of the nineteenth century), says: "In the park adjoining the garden in about 1805 were five large sweet chestnut trees, one of them measuring 37ft. round, still bearing fruit plentifully, though much shivered and decayed by age. The largest, completely hollowed by age, was blown down some years ago by boys and men destroying wasps' nests, but its immense trunk is still lying in the park. There are, however, two very fine old ruinous trees of this sort left; one of them quite hollow and of great size still carries a large green head, and every year produces nuts abundantly." I have recently seen what I suppose is this latter tree. It measures 37ft. 8in. in girth, and stands near Nineveh Court. It is certainly a striking and most interesting relic. The beautiful specimen of tithe barn that used to be-

long to the Abbots of Glastonbury has a roof of Spanish Chestnut made like the beams of a ship and pegged together.

The former existence of the chestnut in the New Forest, according to Wise, "is shown by the large beams in some of the old forest churches, as at Fawley; but none now exist, except a few comparatively modern, though very fine, at Boldrewood." This statement may have been true fifty years ago, but according to Mr. P. Trentham Maw there are plenty of Spanish Chestnuts now in the New Forest. "One enclosure adjoining Knightwood is nearly all Spanish Chestnuts."

Walnut.

The walnut, as its name implies, is not a native, for in Anglo-Saxon speech, according to Sir Herbert Maxwell, it was the *Wealh Knut*, or the foreign nut. The Romans may be safely credited with having introduced this valuable tree. It has become thoroughly adapted to the soil and climate of the British Isles, as in the case of the Spanish Chestnut. Apart from its fruit, it has distinct merits as a timber tree, yielding valuable hard wood.

Of the many fine walnut trees in the southern parts of England there is a noble specimen growing at Barrington Park, Oxfordshire. In 1903 it was between 80ft. and 85ft. high, with a girth of 17ft. The bole and main branches were covered with burrs, showing that the timber would make beautiful panelling and veneers. In the "Guide to Dorset" (1908) Mr. Frank R. Heath writes: "Just N.W. of Cranborne, on the Wiltshire border, on the fringe of the famous Chase at Woodyates, is Lord Londonderry's famous 'hundred pound' walnut tree, a pretty good annual yield from a solitary contributor." Mr. C. J. Salway Waters, the squire of Woodyates Manor, where this fine walnut still flourishes, informs me that it measures 17ft. in girth, with an approximate height of 90ft. The crop of fruit, just gathered, is not so large as usual. At the Moot at Downton the tallest of several walnut trees there is about 100ft. in height. Another, about 80ft. in height, has a girth of 17ft. 2in.

Mr. E. S. Wilbraham, agent to Lord Shaftesbury, recently sent me specimens of leaves and nuts from an exceptionally large tree of the American Black Walnut, 70ft. high, with a girth of 13ft. 3in. The diameter of the area covered by the branches was 70ft. The American Black Walnut is sometimes confused with one of the Hickories, but it is easily distinguished by the pith of the growing shoots being arranged in thin transverse plates. In the Hickories it is continuous.

Pea Flowered Trees.

Among trees bearing pea flowers (*Leguminosæ*) there are a few that deserve mention here. Among the first is what is known as the "Judas Tree," so called because it was the tree on which Judas was supposed to have hanged himself. Shakespeare, however, entertained other views, for in "Love's Labour Lost" he

makes Biron say to Holofernes, "Judas was hanged on an elder." A remarkable Judas Tree is met with at Wick House, near Christchurch, the residence of the Hon. F. J. Lascelles. Some years ago it was blown down, and it was left lying on the ground. Notwithstanding this misadventure it still survived and now covers an area of 40ft. by 20ft. The main trunk measures 6ft. in girth. A young Judas Tree, of bushy habit, about 20ft. high, grows near. Both trees are covered with rosy flowers, which break out from all parts of the stems and branches early in May.

The Common Robinia, sometimes called an Acacia, is a beautiful tree with white flowers, very common in the Bournemouth district. The Robinias with pink and rose coloured flowers, are still more attractive. The Pagoda Tree (*Sophora*) is another attractive tree, seldom seen here. The blossoms appear in August and September. They vary in hue from white to yellow, with a tinge of purple. The Common Laburnum is a charming spring-flowering tree; but some forms of what is known as the Alpine or Scottish Laburnum, which blossoms a fortnight later, are much handsomer, and deserve to be more widely planted.

Although not a pea-flowering tree mention may be made of the Tulip Tree, which belongs to the same family as the Magnolia. There are two fine specimens at Canford Manor, the largest is 62ft. in height, with a girth of 9ft. 6in. An equally large tree is growing in the rectory grounds at Wimborne St. Giles, and another at Creech Grange. Mr. Hargreaves informs me that a handsome Tulip Tree at Cuffnells is 102ft. in height, with a girth of 10ft. 2in. The Tulip Tree is a beautiful object with its bright green foliage in summer; and its tracery of smooth grey branches in winter. The Ailanthus, or the Tree of Heaven (on account of its great height) is as admirably adapted for street planting as the plane, and accommodates itself equally to the noxious air of London. The tallest specimen in this neighbourhood is probably that at Charborough Park, measuring 78ft. in height, with a girth of 9ft.

Planes.

There are two well-known planes, usually met with in this country—the Oriental Plane and the London Plane. What is known as the American or the Western Plane has often been introduced, but it is generally accepted that it has nowhere proved a success. I have met with no specimens of the true Western Plane in this neighbourhood.

Although the Oriental Plane has been cultivated in England since the middle of the sixteenth century, it is getting comparatively rare in some districts, having been ousted by the more rapidly-growing London Plane. It is easily distinguished from the latter by its shorter and more rugged trunk and its deeper, often doubly-lobed leaves. Few trees are longer-lived than the Oriental Plane. There are two interesting references on this point: On the banks of the Bosphorus there is a group of trees under which the Knights of Godfrey de Bouillon on their way to the Crusades are

said to have sheltered in 1069. While under a tree still living on the Island of Cos in the Ægean Sea, its trunk 54ft. in circumference, tradition says that Hippocrates sat more than 400 years B.C.

Among fine British specimens of the Oriental Plane Mr. Elwes gives first place to a tree in the Palace Gardens at Ely, planted by Bishop Gunning between 1674 and 1684. It is therefore over 230 years old; it is more than 100ft. high, and more than 20ft. in girth. A fine specimen at Kew has a trunk 13ft. in girth.

In this district at Bisterne, near Ringwood, there is a very fine Oriental Plane, that measured in 1906, 100ft. in height and 18ft. in girth. The largest Oriental Plane at Canford is 65ft. by 7ft. 8in. in girth. At Wimborne St. Giles, Mr. Wilbraham measured for me a tree with a girth of 15ft. 1½in., and at Merly House, near Wimborne, Mr. Basil Levitt reports a well-grown Oriental Plane, with a girth of 11ft. 4in. The well-known Gilpin's Plane in the Vicarage Garden at Boldre is a typical Oriental Plane. Its estimated height is 85ft. to 90ft. Its girth at 5ft. is 16ft. 4in. The stem has numerous large burrs, and at 15ft. divides into five huge spreading limbs. The diameter of its umbrage is 100ft. It is in vigorous health and well cared for.

The London or Maple-leaved Plane (*Platanus acerifolia*) is characterised by a smooth erect trunk, whose bark peels off in flakes. It has a rounded head, and the ends of the branches are usually pendulous. The shoots and leaves are at first covered with a dense brown wool; much of this falls away in the autumn. The leaves are five-lobed but not nearly so deeply cut as in the Oriental Plane. It is singular that the origin of this remarkable tree is not known. It first came into notice early in the seventeenth century. There is a specimen at Heron Court, planted in 1707. In London it has been established in greater numbers than all other trees put together. It certainly has the power to withstand a smoke-laden atmosphere better than any tree at present known. There are fine groups in Berkeley Square and near the Admiralty at Whitehall. Sir Herbert Maxwell is of opinion that the avenue of Planes, not long ago planted along the Mall, leading to Buckingham Palace, in fifty or sixty years, will be one of the sights of Europe.

Probably the tallest London Plane in England grows at Woolbeding, in Sussex. In 1903 it was 110ft. high, with a girth of 10ft. and a bole of 30ft. The London Plane at Heron Court, above referred to, according to Mr. Elwes "measures 90ft. by 11ft. 5in., and has a stone at the base with the date 1707 cut on it. A woodpecker's hole in the trunk, which is clear for about 30ft., shows that this tree has begun to decay." A recent measurement of this tree, made by Mr. P. Trentham Maw, makes the girth at 5ft., 11ft. 10in. Another Plane on the South Lawn at Heron Court, near the large Lebanon Cedar, has a girth of 14ft. 0½in. at 2½ft., where it gives out several large branches. At Avon Castle, near the front entrance, and partly overhanging the river, Lord Egmont was kind enough to assist me in measur-

ing a fine Plane that girthed 16ft. with an estimated height of 70ft. There are not many planes in gardens in Bournemouth. There is a group on the Horse Shoe Common, planted about seventeen years ago, doing fairly well.

Limes.

The small-leaved lime is an undoubted native but is not common in this district. Sir Herbert Maxwell claims that the correct English name is "line" or "linden tree"—linden being the adjectival form of the Anglo-Saxon lind. The root meaning of the word according to this authority is "smooth," referring to the texture of the wood. There are many specimens of the small-leaved lime in England, but it is nowhere so large as the common lime. There are numerous fine avenues of the latter. A very notable one in Hants is at Stratton Park (Lord Northbrook's). The lime is tolerant of drought, parching heat and a smoky atmosphere, and on that account it has been largely used in street planting. The fine limes in the Cathedral Close at Winchester "afford a felicitous association of foliage with noble architecture."

The White Lime (*Tilia tomentosa*) and the Pendant Silver Lime (*T. petiolaris*) are very ornamental trees.

Hornbeam.

This is a somewhat uncommon tree in this district except in one or two localities where it occurs in hedges. The timber is reported to be the hardest, heaviest and toughest. It competes with foreign wood in the pianomakers' trade, while its firm texture, resembling that of ivory or horn, renders it excellent for fine action work. Mr. Elwes has drawn attention to "the beautiful tree of Hornbeam growing at Heron Court, near the front entrance." He gives its measurements as follows: 70ft. in height, 10ft. 5in. in girth, with a spread of umbrage of 25 yards. A measurement lately made by Mr. Trentham Maw gives a girth of 11ft. at 3ft. 6in. from the ground.

Yew.

There is probably no native tree except the oak that is regarded with greater veneration than the yew. Owing to the practice continued from the earliest times of planting yews near ancient temples and later in churchyards, they have become very closely associated with our national life and folk-lore.

The yew is remarkable for forming an enormously thick trunk, which is clothed with a red-brown peeling bark, and crowned with a rounded and wide-spreading head of branches. The foliage is thick, dark and glossy, and gives the yew a characteristic sombre appearance. Shakespeare speaks of it as the "dismal yew," Sir Walter Scott refers to "a grove of sable yews," while Tennyson speaks of its "thousand years of gloom," and assigns to it the pious duty of "warden of buried bones." The seed of the yew is enclosed in a fleshy red, and sometimes

yellow cup. The latter is frequently eaten without ill effects, but the seed is certainly poisonous.

Yew wood, for many centuries, was used for making bows, which was our national weapon before the discovery of gunpowder. A. Conan Doyle writes:—

“ So men who are free
Love the old yew tree
And the land where the yew tree grows.”

The yew is an excellent evergreen tree for soils containing lime. Besides solitary trees, there are also some forest areas covered with yew. Possibly the largest of these in England is on the downs west of Downton, Wilts, the property of the Earl of Radnor. The yews here cover about eighty acres. There is also a large yew wood at Cherkley Court covering fifty or sixty acres.

In addition to forming excellent evergreen hedges, it bears clipping exceptionally well, and is the principal tree used for topiary work, i.e., training and clipping into formal and fantastic shapes. The most remarkable examples of this work are at Levens Castle in Westmoreland, and at Elvaston Castle in Derbyshire. Some of these have been in existence for two hundred years, and have been annually clipped ever since. At Bingham's Melcombe, the residence of Mrs. Bosworth Smith, is a stupendous yew hedge 20ft. high and 20ft. through. It is said to date from the time of Henry VIII.

The standard work on the “Yew Trees of Great Britain and Ireland,” by John Lowe, M.D., London, 1897, should be consulted by those interested in yew literature.

In estimating the age of yew trees, as pointed out by Dr. Lowe, it must be borne in mind that counting the rings of growth is only possible in young trees. It is entirely erroneous in old trees owing to the welding together of young shoots that takes place outside, and sometimes inside, the original stem, giving the tree a fictitious appearance of age. In such cases the yew is not a single tree, but an aggregate of adventitious growths.

In too many instances it is assumed that the age of yews in churchyards is coeval with that of the church. This may be a plentiful source of error. A statement may be quite correct that a yew tree once grew at a certain spot at a certain time, but it does not necessarily follow that that original tree still occupies the same spot. The average rate of growth of yews given by Dr. Lowe is one foot of diameter in sixty or seventy years, both in young and old trees. As a general statement this may be usefully borne in mind when estimating the age of yews. One of the oldest yews in this neighbourhood is probably that in Brockenhurst Churchyard. This stands close to the decayed remains of a fine old oak. Wise gave the circumference of this old oak (about 1860) as 22ft. Dr. Lowe gives the following brief account of the yew:—“A fine tree in Brockenhurst Churchyard in the New Forest, Hants, in 1793, had a girth of 15ft., and was up-

PLATE I.

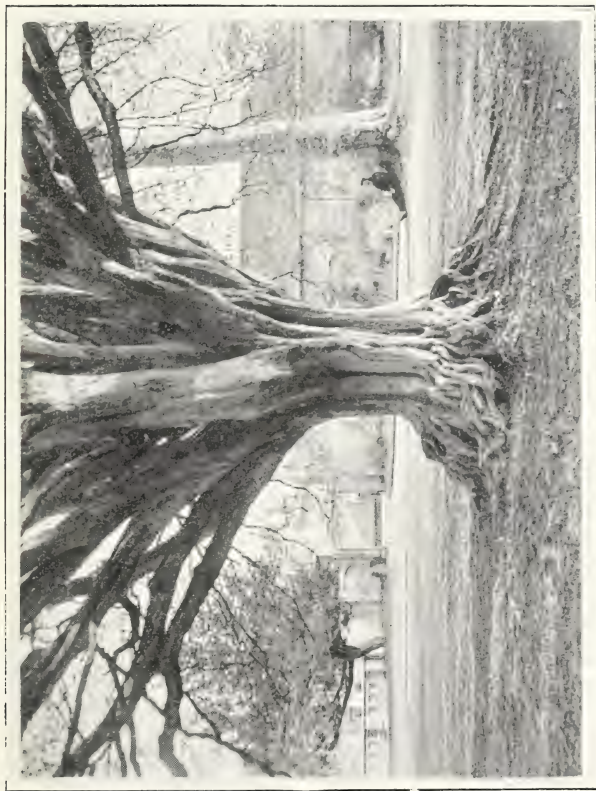


Photo by E. Dodshon.

Hornbeam Tree at Heaton Court.



wards of 60ft. in height. In 1892 the head was still unbroken, and about the same height, and with a spread of foliage of about 70 yards in circumference. At 3ft. from the ground it girthed 18ft., which gives about 1ft. in diameter in one hundred years—a very slow rate.” The girth of this tree when I measured it in October, 1915, was 18ft. 4in., the height about 60ft., while the diameter of the ground covered by the branches was 70ft. It is stated that the church(or possibly a chantry) at Brockenhurst is mentioned in Domesday. It was built on an artificial mound on the top of a hill, to serve as a landmark in the forest. After describing the church, Wise says: “ Behind it in the churchyard spreads the gloom of a yew which from the Conqueror’s day to this hour has darkened the graves of generations.”

A venerable looking yew in the churchyard at Wimborne St. Giles measured 22ft. in girth. I can find no authentic records of this tree. At Tisbury, on the borders of Wilts, there is a very old yew of which an illustration is given both by Dr. Lowe and by Elwes and Henry. Elwes measured it in 1903 and made it about 45ft. high and 35ft. in girth. He said it was a female tree, but of its age it was impossible to form a correct estimate. It is in fine foliage, although the trunk is quite hollow. In 1834 the tree was entered by a rustic gate, and seventeen persons were said to have breakfasted in its interior. There must have been some considerable internal growth since 1834, for in 1897 it was said that only nine persons could stand inside. The Rev. E. F. Linton, F.L.S., has kindly obtained for me measurements made by the Rector of Breamore of a venerable yew tree in Breamore Churchyard. At 5ft. from the ground the girth was 34ft. It is divided into many segments and portions here and there have disappeared.

What is known as the Irish yew is a singular form of the common yew found wild on the hills near Florence Court in Ireland in 1767. This grows in a columnar form with the habit of a Lombardy poplar. It has been propagated entirely by cuttings, so that all the Irish yews in all temperate parts of the globe have been derived from this one plant. Sir Herbert Maxwell remarks at best, the Irish or Florence yew is a funereal subject, and a more cheerful effect may be obtained by planting other trees. At Avon Castle, for instance, there is an exceptionally attractive series of the golden and glaucous form of Lawson’s cypress and the Monterey cypress all of columnar habit and in excellent condition. One of these is 42ft. high.

Ginkgo, or Maiden-Hair Tree.

The Ginkgo is a deciduous tree which is regarded as somewhat distantly related to the yew. It is probably a native of Western China, but as a sacred tree it is now chiefly found in the neighbourhood of temples in China and Japan. It is a beautiful tree. The light green fan-shaped leaves suggest a gigantic maiden-hair fern. As the fruit and leaves, found in a fossil state

in secondary rocks, are almost indistinguishable from those of the present day Ginkgo, there is little doubt that we have here a remarkable survival of a very ancient flora, that covered, not only this country, but parts of North America and Greenland. Ginkgo trees are unisexual, that is, the male and female flowers are on different trees. The fruit is plum-like, about one or two inches long. It is probable that most of the large trees in this country are males. Fruit-bearing trees, are, however, fairly common in Southern Europe, where seed is regularly produced. It is recommended that trees raised from seed should always be planted in preference to those obtained from cuttings. A fine ginkgo tree grows in the corner of Mr. Lascelles' garden at Wick House, near Christchurch. The trunk is divided, low down, into a large middle and two side stems, and below these measures 5ft. in girth. The top is bushy, and attains a height of 30ft. From the position in which this interesting tree is placed, with high walls close to it, on two sides, it is not possible to see it to advantage. Nevertheless, it is probably the largest tree in this neighbourhood and deserves to be preserved. The tallest Ginkgo tree in England, 80ft. in height, is said to occur at Melbury Park, near Dorchester. Another Dorset specimen, 70ft. in height, is reported from Sherborne. Perhaps the best-known Ginkgo is that at Kew, which in 1904 measured 62ft. in height, with a girth of 10ft. 4in.

Pines.

Passing from the broad-leaved trees, some native, some foreign, we now come to the cone-bearing trees, usually with linear-narrow leaves. The most important of these are the pines, and a familiar representative is the Scots pine, which is found everywhere in this neighbourhood. Its scientific name *Pinus sylvestris*—the forest pine—is more appropriate than Scots pine, for the tree is not confined to Scotland, but is native of nearly all Europe, including Britain, and extends across Siberia almost to the Pacific Ocean. It thrives as well under the summer heat of Southern Spain as in the humid atmosphere and cold soils of Norway and Sweden. In former ages the Scots pine covered large areas in this country, and its numerous trunks found everywhere in mosses and peat-bogs attest its abundance in prehistoric times. After disappearing during the glacial period it was re-introduced to Southern England in the middle of the eighteenth century, when the present considerable areas covered with Scots pine were established from planted and self-sown seedlings. Details of this interesting event are given in "Bournemouth in 1810-1910."

There is a very interesting group of four Scots pines on the south lawn at Heron Court. It is a tradition in the family that the seed from which these were raised was brought from Scotland by a relative who fought at the battle of Culloden in 1746. It is probable that these trees were planted at least thirty years before the Scots pine was re-introduced into the New Forest. The date

usually given for this is 1776. The largest of the trees at Heron Court is 89ft. in height, with a girth of 8ft. 7½in. A Scots pine at Canford Manor is 90ft. high, with a girth of 8ft. 7in.

Possibly the second largest Scots pine in England is that growing at Brooklands, near Romsey, the seat of Mr. Wilfred W. Ashley, M.P. This in 1916 measured 105ft. in height, with a girth of 13ft. 4in. It has a clean stem up to 40ft. and is a very striking object.

Taking stock of the pine trees now met with in the immediate neighbourhood of Bournemouth the Scots pines easily come first in number. They are found everywhere. Next comes the Pinaster or maritime or cluster pine introduced about a hundred years ago from Southern France, and lastly the recently planted Austrian pines. Among the less known pines are the handsome Monterey pine (*P. insignis*), the Stone pine, the Corsican pine, Weymouth pine, Swiss Stone pine (*P. cembra*), and the Himalayan pine (*P. excelsa*). The pines planted on the Horseshoe Common in 1898, that is seventeen years ago, form an interesting object lesson in tree names. There are at least ten species which may be studied at leisure. There are also spruces and cedars. [Sketch plans of the Horseshoe Common, the Upper Public Gardens, and the Winter Gardens at Bournemouth were shown to illustrate the position of the more interesting cone-bearing trees.]

The most ornamental and satisfactory of the pines in this district is undoubtedly the Monterey pine. The leaves are in threes, of a rich grassy green, long, soft, and flexible. The cones are three to five inches long and usually produced in whorls of two or three. It is a rapid growing tree. Trees in good soil at Lymington are known to have reached a height of 60ft. in 21 years. The finest specimen in this neighbourhood at Heron Court measures 110ft. 8in. in height, with a girth of 13ft. 6in. at 5ft. Another growing at Cuffnells, in the New Forest, in 1907, measured 116ft. in height, with a girth of 8ft. 6in. The largest Monterey pine at Canford Manor is 80ft. in height, with a girth of 13ft. 6in. At Hinton Admiral there is a tree 15ft. in girth at 3ft., with a height of about 70ft.

The interesting Stone pine (*P. pinea*) is highly valued for its edible seeds. As their husks have been found in the refuse heaps of Roman encampments in Britain they would appear to have been sent for the use of the army of occupation. There are two localities in this district where the Stone pine is found in a thriving condition. Mr. Elwes gives the following interesting account of the trees growing at Matcham Park, near Ringwood:—"If I had not seen the remarkable plantation of this pine at Matchams, near Ringwood, I should have supposed that it was impossible for it to develop its normal character in any part of England, but here it seems so much at home that the conditions under which it grows are of interest. Mr. Hamilton Leigh, owner of the place, informs me that the trees were raised from seed sent by Lord Nelson from the Mediterranean about one hundred years ago, to

the owner of the estate. They grow close to the road and railway, at the foot of a great sandhill on the open barren heath, two or three miles south-west of Ringwood, in sand, which is never apparently dried up in summer, owing to the percolation from the hill above; the trees being well sheltered from the south-west and drawn up by maritime pines which grow around them. They have the umbrella-shaped head of the true Roman pine, and are from 50ft. to 60ft. high by 4ft. to 5ft. in girth. They produce cones abundantly, which are attractive to squirrels, which eat the seed before it falls. By their bark, their cones, and their habit they are easily distinguished from the maritime pines." Mr. Elwes makes further reference to similar trees growing at Heron Court, the largest of which is no less than 13ft. in girth at 2½ft., where it divides into large branches, but does not exceed 40ft. to 45ft. in height. There are two groups in the park of smaller size all of which seemed to bear ripe seed in 1906.

It is not improbable that the Stone pines at Heron Court were planted at the same time as the trees at Matcham Park, and that the seed came from the same source. It may be useful to recall that Lord Nelson's sister (Mrs. Matcham) lived at Matcham Park during the time he stayed at Calshot Castle near Southampton; also that the first Earl Malmesbury was an intimate friend of Lord Nelson's. The story, therefore, about the seeds of the Stone pine having been brought by Lord Nelson from the Mediterranean and planted at Matcham Park and Heron Court is not at all improbable. Mrs. Matcham's grand-daughter (Mrs. Crowther) died at Branksome on December 26th, 1915.

For planting on the Bagshot beds in Hants and Dorset the Corsican pine is recommended in preference to the Douglas fir, which seldom thrives in such situations. Mr. Alfred Pope, Mr. Lane, and others are carrying out some interesting tree planting experiments in Dorset with various conifers. The Corsican pine is apparently giving good promise of success. The specimen Corsican pine in the Queen's Drive at Canford Manor is 110ft. high, with a girth of 9ft. 6in.

Silver Firs.

In the silver firs the cones stand erect on the branches, while in the other group of firs, the spruces, they usually hang down. There is another point of difference, the leaves in the spruces are set upon little pegs which remain on the twig when the leaves fall. The silver firs are so-called because usually they have grey or silvery bands on the under side of the leaf. There are no silver fir native of Britain. What is known as the common silver fir (*Abies pectinata*) has been introduced from Southern and Central Europe, but it has found a congenial home in these islands. Members of the Society will remember that they saw some handsome silver firs when, by the courtesy of Mr. Bond, they lately visited Creech Grange, near Wareham. For purposes of timber probably the common silver fir and

the Caucasian silver fir (*A. Nordmanniana*) are the best, but for decorative purposes there are many species of singular beauty such as the noble silver fir (*A. nobilis*), the gigantic silver fir (*A. grandis*), and the Colorado silver fir (*A. concolor*). The Santa Lucia silver fir (*A. bracteata*) is possibly the most remarkable of any for its size and beauty and its egg-shaped purplish-brown cones. A fine tree of this is growing at Eastnor Castle in Herefordshire. I have not met with a large specimen in this district. Closely allied to the silver firs is the Douglas fir (*Pseudotsuga douglasii*). This is fairly common in this district. One of the best specimens is growing at Canford Manor. This is 105ft. high with a girth of 10ft. 11in. Of other silver firs I have seen in this district at least ten species whose locality and dimensions have been duly noted.

Among the Hemlock firs the largest and most stately is *Tsuga Albertiana* of North-West America. It is a very graceful tree and one of the most effective conifers for the park and landscape on account of its broad sweeping habit. One of the finest trees I have seen is growing at Westonbirt, Gloucestershire. This species is far superior to the Hemlock spruce of Canada.

Spruce Firs.

The so-called Norway Spruce (*Picea excelsa*) has a natural range extending from the Pyrenees to Western Russia. It is possibly, next to the Scots pine, the conifer most commonly seen in British woodlands. It does not thrive under the influence of salt-laden winds so it is generally confined to inland districts. Its timber is imported in large quantities from Norway as "white deal." There are many exceedingly ornamental spruces. The Himalayan *P. Morinda* with handsome pendulous branchlets is one of the most striking. A specimen of this at Charborough Park is 84ft. in height with a girth of 9ft. 8in. A very decorative spruce is the glaucous form of *P. pungens* known as *Kosteriana*. The American Sitka spruce is a very hardy moisture-loving tree. It is said that no other spruce makes such good light oars, and the timber on that account is imported specially for that purpose. There are specimens of this growing in the Upper Pleasure Gardens and in front of Heron Court Estate office, near Hurn Bridge. Probably the largest tree in these islands is at Castle Menzies, Perthshire. In 1904 it measured 110ft. high with a girth of 13ft. 2in. There are over twenty introduced spruces grown in these islands and at least a good dozen or more are found in parks and gardens in this neighbourhood.

Cedar.

The name Cedar is applied to various trees, but more especially to the cedar of Lebanon and its geographical forms, the Atlantic Cedar and the Deodar of the Himalayas. We have scriptural authority for assigning to the Lebanon cedar royal pre-eminence among trees. Ezekiel says no "tree in the garden of

God was like unto him in beauty." In this country it is "as familiar an adjunct to English manor houses as the yew is to churchyards." The Lebanon Cedar therefore requires no introduction here. Some remarkably fine specimens are growing on the lawns at Heron Court. There is a stone close by bearing the date 1815, so these noble trees, planted in the year of Waterloo, are now over one hundred years old. The largest is about 65ft. high with a girth of 16ft. 1½in. At Kingston Lacy I saw recently a Lebanon Cedar 70ft. high with a girth of 17ft. It had a tablet at the foot stating it was planted by the Duke of Wellington in 1827—that is twelve years after the battle of Waterloo. There are no doubt similar Lebanon cedars with equally interesting historical associations in many parts of the country. From the point of view of size, that is, for height and girth combined Elwes says there is no Lebanon cedar to equal the splendid tree at Pains Hill near Cobham in Surrey. In 1904 this measured 115ft. to 120ft. in height with a girth of 26ft. 5in. Perhaps the tallest cedar in England is at Petworth Park, which in 1905 was not less than 125ft. by 14½ft. in girth.

Sir Herbert Maxwell says "on the whole the best species of cedar for planting in this country, whether for timber or ornament, is the Cedar of Mount Atlas or Atlantic cedar." This differs from the Lebanon cedar in its more erect habit and its less tendency to wide-branching. The branchlets are not pendulous and are usually covered with a short dense down. There is little difference in the length of the leaves, but they are usually as thick or thicker than broad. The cones are usually shorter and more cylindrical. In one variety of the Atlantic cedar the leaves are more or less deciduous. There are quite a number of very ornamental glaucous forms well worthy of cultivation. Occasionally self-sown seedlings come up near the parent tree as at Cooper's Hill, near Windsor. A fine Atlantic cedar 72ft. in height with a girth of 13ft. 8in. grows in the grove of Charborough Park. Another flourishes at Canford Manor which is 75ft. high, with a girth of 13ft. 5in. There is a further tree in Cedar Wood Park 95ft. in height with a girth of 12ft. 4in. and a glaucous variety also at Cedar Wood Park 75ft. in height with a girth of 6ft. 2in.

Ordinarily the Deodar may be distinguished from either the Lebanon or Atlantic cedar by the graceful drooping of its branches and the longer needles. Two well-marked varieties are known with green and glaucous foliage. The deodar is found wild in the Western Himalaya at 4,000 to 10,000ft. It there attains a large size. Probably on account of the great difference in climate the deodar has not fully adapted itself to the conditions in this country. As Sir Herbert Maxwell remarks, "our mild restless winters and cool summers" may account for this. Large numbers of deodars were planted in the New Forest in the spring of 1856, but it was reported that they proved a failure as they died off unaccountably when about forty or fifty years old. The Hon. Gerald Lascelles mentioned that there were some notable excep-

tions, such as the grove at Boldrewood, where the best deodar measured 64ft. in height. Mr. Elwes ventures the opinion that the dying off in deodars is most common on soils that are poor in lime. As an ornamental tree there are few in the world that can compare with the deodar. I am not in a position to speak definitely as to the general success or failure of the deodar in this immediate neighbourhood. There are some fairly good trees to be met with in some parks and gardens, but none of exceptional size. In the Winter Gardens in Bournemouth there are two fairly well-grown trees. In the public gardens immediately above the Square there are three trees, while further up there is a pendulous form. At Hinton Admiral I have come across an interesting plumose variety of deodar not yet determined.

Larch.

As a garden tree, Mr. Bean says the common larch has much to recommend it as it is singularly beautiful when grown as an isolated specimen, and no tree exceeds it in the soft tenderness of the young green foliage. There are two weeping forms. From the point of view of yielding timber it is said "that no tree ever introduced to Britain has proved of so much value or been so extensively planted. For many years its economic value has exceeded that of any other tree—even the oak." In Scotland the Duke of Atholl before his death in 1764 altered the appearance of the landscape by planting many square miles of hillside with larch. His example was followed by other landowners both in Scotland and in England for it was found that owing to the durable character of the wood even in young trees, from ten to twenty years old, the thinnings of a larch plantation were serviceable and readily saleable. Unfortunately the larch disease (*Chermes*) has done an immense amount of damage to plantations. The remedies suggested (1) not to expose larch to contact with the Norway spruce and (2) not to plant it as a pure crop but mixed with other trees may do much to combat the disease.

In Scotland self-sown seedlings of larch are often seen and are encouraged. On the suggestion of Mr. Maw I made a search for such seedlings on Minchinghampton Common, near Stroud, in the Cotswold country, and found quite a number on the slopes and margins of roads.

The Japanese larch, a fast growing species, when young, has been tried as an alternative species, but serious doubts are entertained whether it will prove as valuable a tree, commercially, as the European species. Attention has latterly been drawn to the merits of the American or Western larch. This has a fine columnar habit and is the mightiest of the genus, reaching a height of 180ft. or more. There are three specimens of the Western larch at Kew about 35ft. high.

Cypresses and Their Allies.

The Cypresses are all foreign trees, but they are so widely

grown in this country and are so decorative and so capable of being turned to advantage that it is impossible to overlook them. The Mediterranean Cypress (*Cupressus sempervirens*) yields timber of so durable a character that it is recorded that the doors of the original basilica of St. Peter at Rome erected in the fourth century were perfectly sound in the sixteenth century. This cypress is hardy only in the southern counties. A handsome tree, probably the best in England, is growing on the lawn at Heron Court. It measures 60ft. with a girth of 5ft. In what is known as the Italian walk there are several other trees, one of a somewhat spreading habit. A common cypress in and around Bournemouth is Lawson's Cypress. There are more than forty named varieties showing a wide diversity in size, shape and colour. The Monterey Cypress (*C. macrocarpa*) is also very common. It varies in habit from an erect to a rather wide-spreading tree. The latter is sometimes known as *C. Lambertiana*. Both forms grow side by side on the lawn at Cuffnells, near Lyndhurst. The prevalence of the species in Bournemouth may be illustrated by the fact that between the Boscombe Gardens and Lansdowne at least fifty trees of the Monterey Cypress are seen dotted about in gardens on both sides of Christchurch Road and its immediate vicinity.

Some of the finest Monterey Cypressess are growing at Hadden's Hill, the residence of Mr. F. G. Hopkins, J.P. The tallest measures 74ft. in height with a girth of 9ft. At Kingston Lacy Park there were several trees over 50ft. with a girth of 7ft. 6in. At Cuffnells a fine Monterey Cypress measures 100ft. in height with a girth of 14ft. A beautiful tree is the Himalayan Cypress (*C. torulosa*). There is a fine avenue of this at Cuffnells raised from seed brought from India by Mr. C. Harland in 1860. It consists of nine trees on each side of a walk. They are very regular in habit and measure about 45ft. by 4½ft. They bore fruit in 1907. There are some specimens of the Japanese Sawara Cypress (*C. pisifera*) in gardens here as well as of the handsome Nootka Sound Cypress (*C. Nootkatensis*). There is a small avenue of the latter at Hadden's Hill.

This is a convenient opportunity to mention a striking looking tree known as the Incense Cedar (*Libocedrus decurrens*). It grows quite erect and forms a tall well-formed column admirably adapted for a group or avenue. A very fine tree about 70ft. high, and quite columnar, is growing at Frogmore. A well-grown tree was noticed on the occasion of a visit of the members of the Society to the gardens at Somerley, the seat of the Earl of Normanton, in 1912.

Another interesting tree is the Japanese Cedar (*Cryptomeria*). This is quite distinct from any other hardy tree. Although one of the great timber trees of the world it has not proved successful in this country although under favourable conditions it ranges from 60ft. to 80ft. in height. One of the best specimens I have seen in this neighbourhood is growing at Charborough Park. It measures 57ft. by 6ft. 9in. The largest in England is at Hemp-

sted in Kent, which Mr. Elwes reports to be 80ft. high by 8ft. in girth.

Wellingtonia and Redwood.

These two trees, regarded as the marvels of the vegetable kingdom, were only discovered about the middle of the nineteenth century. Their introduction created extraordinary interest and large numbers of young trees were established in gardens all over the country. Many of these are now very equal in size. In many localities, as might be expected, they proved a failure, while in others a great success. The first to be discovered was that called by Lindley Wellingtonia (*Sequoia gigantea*) in honour of the great warrior. This is an evergreen tree reaching in the Sierra Nevada of California a height of 250ft. to 325ft. Some of these giants probably antedate the Christian era. In old trees in their native country the branches begin at 100ft. to 150ft. The leaves are blue-green completely covering the branchlets. The cones are comparatively small only 1½in. to 2in. long. The Wellingtonia differs from the redwood in not reproducing itself either by suckers from the root or by coppice shoots. There is a pendulous variety as well as one in which the young shoots are amber-coloured at first and then become deep yellow. One of the largest Wellingtonias in the country grows in a sheltered glade at Fonthill Abbey and in 1906 was probably over 100ft. in height. I have measurements of a Wellingtonia made by Mr. McCullum, the forester at Canford Manor, of a tree growing in Cedar Wood Park estimated to be 100ft. in height with a girth of 13ft. 9in. A tree at Merly House, near Wimborne, growing in a sheltered dell and closely surrounded by other trees is estimated to be over 100ft. high with a girth of 8ft. 4in. A Wellingtonia at Charborough Park measured by Mr. Milne is 72ft. in height with a girth of 9ft. In Beech House Gardens, near Hinton Admiral, Mr. Rogers, gardener to Sir George Meyrick informs me there is a Wellingtonia 70ft. to 75ft. high with a girth of 15ft. 7in. The Redwood (*Sequoia sempervirens*) the other giant tree, is also a native of California and parts of Oregon, where it occupies a narrow strip of country along the sea coast. It attains a height of 340ft. and occasionally 50ft. to 75ft. in girth. The bark is sometimes six to twelve inches thick. The leaves differ from those of the Wellingtonia in being flat and slightly grey or whitish underneath. The cones are smaller, $\frac{3}{4}$ to 1in. long. Redwood timber is highly valued for building; it is reddish, free from resin, and of a light soft nature. There is one variety with the young shoots creamy white. There is a very large number of redwoods in various places in this country. In reference to one group, Mr. Elwes writes: "In a sheltered dell, known as the wilderness at Cuffnells, near Lyndhurst, the seat of Mr. R. Hargreaves, are three splendid redwoods which were planted about the year 1855 by his father." These measured (about 1908) 102ft. by 10ft. 8in., 98ft. by 15ft., and 105ft. by 10ft. 10in. respectively; the last being equal or superior

to the one at Claremont, described as the finest in England, and growing close to a magnificent tree of *Pinus insignis*. The largest redwood at Canford Manor measures 70ft. with a girth of 11ft. 6in. At Merly House there is also a large Redwood tree.

Araucaria.

This is regarded as another survival of the vegetation of a remote geological period. There are many species of *Araucaria*, but only one *A. imbricata* (the common monkey puzzle), a native of Chile, is hardy in Great Britain. In its general aspects it is probably the most remarkable tree introduced into this country. Its quaint character and the readiness with which it grows when placed under favourable conditions has rendered it a general favourite. On the other hand when it is attempted to grow it in unsuitable soil and among inappropriate surroundings there is no tree that looks so unhappy and miserable. The manner in which it was obtained from Chile is well worth recording. Archibald Menzies in 1795 was a member of Vancouver's voyage of survey in the Pacific. When in Chile he brought away some curious nuts put on for dessert whilst he and the ship's officers were dining with the Viceroy. He sowed these nuts on board ship and ultimately landed five plants (which proved to be the *Araucaria*) safely in this country. One of these five plants was grown at Kew and during my period of service there I used to pass it almost every day. It ultimately died in 1892 when nearly a hundred years old. The male and female flowers in the *Araucarias* are usually borne on separate trees, but very occasionally they appear on the same tree. The cones take two seasons to develop. When fully grown they are globose and about 5in. to 7in. in diameter. This year (1015) *Araucarias* all over the country have coned very freely. Many self-sown seedlings are sometimes produced; and very occasionally a sucker is thrown off from the roots. A photograph of a sucker attached to a tree at Ashton Court Estate, near Bristol, was shown]. I have, at this moment, only one measurement of a large *Araucaria* in this immediate neighbourhood. This is growing at Beech House, near Hinton Admiral, the property of Sir George Meyrick, Bart. It is a fairly handsome tree, 50ft. high with a girth of 7ft. 1in. The largest tree quoted by Elwes and Henry is at Tortworth Court, in Gloucestershire, the residence of Earl Ducie. In 1904 it was 53ft. in height, with a girth of 7ft. 6in.

Report of General Summer Excursions, 1916.

Bindon Abbey and Wool. The first Summer General Excursion took place on Saturday, May 31st, conducted by Rev. Hy. Shaen Solly, M.A., Chairman of the Archaeological Section, and attended by 92 members.

Going to Wool by train and passing over the fine old bridge, they first visited the Manor House immortalised by Thomas Hardy in his "Tess of the D'Urbervilles." Mr. Solly spoke of the Turbervilles, who possessed much property and exercised much influence in Dorset, and the name of Sir Pagan de Turberville appears on the roll of Battle Abbey as one of the Knights who came over with William the Conqueror. The principal seat of the Turbervilles was at Bere Regis, where the Church monuments and family vault still remain. The house at Wool was the seat of a younger branch of the family and is of Tudor or early Jacobean architecture; the date over the porch is 1635 or 1655.

The party then went to the Church, where they were received by the Vicar, the Rev. E. J. Tadman, who pointed out some of its interesting features, the 15th century triple chancel arch, almost unique, and the font built into one of the pillars. They were also shown the Registers, which date from 1583, a chalice dated 1571, and also a beautiful Pre-Reformation chalice, declared by experts to date from about 1480.

A pleasant walk across the fields led to Bindon Abbey. Here Mr. Solly gave an account of the earliest Monastic Orders of note, founded by St. Benedict of Nursia in 529 A.D., and of the revival under the Cistercians of Bindon Abbey, which was first founded by them at Little Bindon, West Lulworth, a wild wind swept place capable of little improvement, and was refounded in 1172 on its present site.

In 1536 it was decreed that all Monasteries of a less value than £200 should be dissolved and handed over to the King, and Bindon was then dissolved, but was re-founded by the King the next year, only to fall finally two years later. Thus Bindon Abbey had three foundations and two dissolutions.

Mr. Solly mentioned that all Cistercian Monasteries followed the same plan in their construction.

Mr. Geo. Brumell, A.R.I.B.A., Hon. Treasurer of the Society, had kindly made several copies of the ground plan of the ruins, and with these in their hands, an inspection of the ruins was rendered the more interesting to the members.

A walk round the Fish Ponds and to the Calvary, followed by tea at the Abbey Gatehouse brought this very pleasant excursion to a close.

Wolfeton House and the "Hardy" Country. On Thursday, June 22nd, an excursion was made through the "Hardy" Country under the guidance of Mr. W. Munn Rankin, M.Sc., B.Sc. The party numbered 79, including 10 Members of the Literature and Art Association.

The journey was made in motor chars-a-banc, the route taken being via Lytchett Minster, Bere Regis and Puddletown Heath, Mr. Rankin pointing out various places and citing many incidents mentioned by Mr. Thomas Hardy, the novelist.

A halt was made at Puddletown Church, where the Vicar, the Rev. A. L. Helps, M.A., described its many interesting features, the fine tombs and stained glass windows in the Athelhampton Chapel, etc.

On arriving at Dorchester, Mr. Harry Pouncy joined the party and accompanied them to Wolfeton House, where they were graciously received by Mrs. Albert Bankes at the main entrance. Here Mr. Pouncy spoke at length on the succession of families who had in turn held Wolfeton, of the Manor House itself, of the objects of interest and treasures of art which it contains, its historical associations and the literary and legendary lore connected with the place. He told of the enforced "visit" of the Archduke Philip and his consort, Joan (afterwards King and Queen of Castile) in 1506, and how the presence on that occasion of John Russell of Berwick led to the founding of the ducal House of Bedford.

After a tour of inspection of the exterior with the Gatehouse, flanked by its pair of massive cylindrical towers with depressed pyramidal roofs of stone tile, the visitors were conducted over the house, noting especially in the drawing room the richly carved oaken doorcase and chimney pieces (a portion of the expression of royal gratitude), and the arabesques of the plastered ceiling, the superb newel staircase (nine steps of stone and forty-one of oak) to the gatehouse and tower, where the "priest's chamber" was visited; the original large stone chimney piece in the saloon and the fine tapestries on the grand staircase were also seen.

Before leaving, Mr. Jas. E. Liddard, F.R.G.S., expressed the hearty thanks of the visitors to Mrs. Bankes.

Lulworth Castle. The third and last of the General Excursions was made on Saturday, July 18th, to Lulworth Castle by the kind permission of Mrs. Weld-Blundell. The Rev. Hy. Shaen Solly, M.A., was the conductor and the party numbered 65.

Arriving in motor chars-a-banc they took lunch under the trees in the park and Mr. Solly read a short paper describing the castle and its history.

A Lulwarde Castle is mentioned as early as the reign of King Stephen, and the present castle is probably on the same site.

The Manor was held by the de Newburghs in the reign of King John. The estate passed by marriage to the Howard family and in 1603 to the Earl of Suffolk, from whom it was purchased in 1641 by Mr. Humphrey Weld. The present castle was erected between 1588 and 1609 by Henry, eldest son of Thomas, Viscount Howard of Bindon, the stone from Bindon Abbey and Poyning's Castle being used for the purpose. The terrace was constructed from the Abbey cloisters, and the beautiful old door now at the servants' entrance is also believed to have come from the Abbey.

Inigo Jones is said to have been the architect; the shape is peculiar. A cube of 80ft. with a circular tower of 30ft. in diameter at each corner, the walls are 6ft. to 7ft. thick.

During the Civil War it was first garrisoned for King Charles, but in 1643-4 it was held by the Parliamentarians as a base of operations against Corfe Castle.

The Weld family is an ancient one, tracing its descent as far back as the reign of King Ethelred. One of the family was Sheriff of London in the reign of Edward III., and another, Sir Humphrey Weld, was Lord Mayor in 1539, and was buried in King Henry VIII.'s Chapel in Westminster Abbey. A widow of an Edward Weld married Thomas FitzHerbert, survived him, and married the Prince of Wales, who became King George IV. Her portrait and pearl necklace are among the treasures of the castle, which also possesses the original seal of the Order of Cistercians. The famous Louterell Psalter is in the possession of the Weld family; it was at one time kept at the castle, but is now in the British Museum.

Thomas Weld was a friend of King George III., from whom he obtained permission to build the Roman Catholic Chapel in 1786, the first since the Reformation; he was made a Cardinal in 1830 and was the first Englishman since the Pontificate of Clement IX. to take part in the election of a Pope.

The castle was visited by several Kings, including King Edward VII. in 1902.

The party went through all the rooms, examined the priest's hiding hole in the "Study," and from the roof enjoyed a fine view of the park. After visiting the Roman Catholic Chapel and walking through the gardens, they drove to the "Black Bear" at Wool for tea and reached Bournemouth about 7 o'clock.

Notes on the Sections and their Work.

THERE were fewer changes in the leadership of the Sections during the year 1915-16 than had to be recorded in Vol. VII.

Dr. Penrose succeeded Mr. Goodall in the chairmanship of the Zoological and Microscopical Section, and secured the services of Mr. H. B. Wells, F.R.M.S., as Secretary, Mr. J. Omer Cooper, who had previously held this position, being absent on war-service. Dr. Penrose continues Chairman of the Entomological Section and Miss M. C. Veale is Secretary. To the lamented death of Mr. Wilfrid Omer Cooper, the former Entomological Secretary, reference is made elsewhere. Mr. Claude Lyon has been at the head of the Geographical Section since the resignation of Mr. G. de Castro, Mr. W. J. Woodhouse continuing to act as Secretary. The resignation of Mr. R. V. Sherring, F.L.S., referred to by the Chairman of the Botanical Section, from the position he had held so long took place at the end of, rather than during, the period with which this volume deals. The regret expressed by the Chairman will be shared by all who know anything of the conspicuous services of Mr. Sherring to the Section and the Society as a whole.

HON. ED.

Archæological and Historical Section.

CHAIRMAN: THE REV. H. SHAEN SOLLY, M.A.
SECRETARY: H. J. ELLIS.

During the past year the subject of Archaeology has been well to the front in the work of the Society, and there has again been much pleasant and fruitful co-operation with other Sections. Most of the lectures dealt with our own locality, though my own contribution took us as far afield as the Catacombs of Rome. Mr. Heywood Sumner explained to us the substance of his book on "The Ancient Earthworks of Cranborne Chase," and gave us a framework into which much else may be fitted. The Rev. F. A. Allen dealt carefully with a time when the tin mines of Cornwall were the principal, if not the only, source of tin for all the bronze of Europe. Mr. H. J. Ellis contributed to the Historical side of our sectional activity by illustrating from the many sources at his command the origin of the Authorised Version of the English Bible. Then we had a joint meeting with the Photographic Section, and Mr. Banks showed us his delightful series of Christchurch photographs. Next we united with the Physical Section, and Mr. Barlow gave us a lucid and elaborate account, founded

on Sir Norman Lockyer's well-known book, of the astronomical data which indicate the date of Stonehenge.

After this we went out of doors, and in May dealt with the archæological interests of Wool Manor House and Bindon Abbey. Uniting with the Geological Section we paid a visit to the interesting old church at Studland. A General Excursion to Wolfeton House conducted by Mr. Rankin and addressed by Mr. Pouncy, had much archæological interest. Then we went to Hengistbury Head, where our old friend, Mr. Brownen, met us and discoursed on ancient British settlements. The visit to Lulworth Castle in July was mainly of historical interest, and afforded an opportunity, not always to be had, of seeing a very remarkable place. The same month included an excursion to Woolsbarrow and Bloxworth Manor House, conducted by Mr. Claude Lyon, and certainly concerned both with archæology and history. This may be said of the last excursion we were able to make, our visit to Woodsford Castle on July 27th, when we examined an ancient building, to view which special permission had to be obtained. Here our appreciation of what we saw was greatly aided, as also when we went to Studland and Bindon Abbey, by plans drawn and copied for us by Mr. Brumell. I wish also to thank Mr. Le Jeune for the advice he gave, and is so well qualified to give, in arranging several of these excursions.

H.S.S.

Botanical Section.

CHAIRMAN : MISS C. AGNES ROOPER.

SECRETARY : [MR. R. V. SHERRING, F.L.S.]

I have much pleasure in giving a good report of the work of this Section during the past year. New plants have been added to those already known in the Bournemouth district and new habitats found for others. The Herbarium, which now numbers about 1,500 dried specimens of the British Flora, has been carefully and systematically arranged by H. E. Swain, Esq. It is with very great regret that I have to record the irreparable loss the Section has sustained in the retirement of R. V. Sherring, Esq., F.L.S., from his post of Hon. Secretary on the plea of failing health. To his constant and energetic labour the Section owes chiefly its present successful position.

C. AGNES ROOPER.

REPORT ON *SPARTINA* GRASS.*

By R. V. SHERRING, F.L.S.

1915-16.

This year has been an eventful one in the history of this grass, both from an economic and a distributional point of view.

Correspondence commenced early in the year with Professor F. W. Oliver, F.R.S., which necessitated further investigation and terminated later in the year with a visit from the Professor, eventually resulting in his report to the Poole Harbour Board (see "Bournemouth Visitors' Directory," November 25, 1916).

The first work done this year was the examination of the Wareham Channel and Arne shore.

Taking a boat from Wareham down the Frome to its junction with Wareham Channel one sees Giggers Island about a quarter of a mile away and at much the same distance from the Trent. It lies a little above high water mark and is, in fact, a succession of large and small tufts of grass intersected by small channels of water. Landing here, a careful inventory of the Flora was taken, resulting in two clumps of *Spartina* being found in the reeds at the south-west end of the island, this bringing the advance of the grass to the head of the Channel. Crossing to the shore a quarter of a mile to the south I landed and examined the shore in the direction of Arne, but no trace of the grass could be seen. (The rest of the report of this district is held over till after the war).

At Arne Bay, between Patchin's and Shipstal Points, the growth of the grass has been enormous, almost meadowing the whole area. A careful examination of the N.W. end of Branksea Island to off Ower shore and thence to Shipstal, round Long and Round Islands to Middlebere Lake and Fitzworth Point, showed that the meadows of grass are still thickening. East of these islands, sweeping away to Goathorn Point, the rapid growth continues.

From Poole northwards and in Holes Bay from Hamworthy Bridge the growth continues and, especially in the north-east section of the bay, there is much new growth. Here, in the spring, was noticed an interesting clump showing the old grass of last season interspersed with the new and surrounded by a dwarf band of bright green colour, evidently showing the new addition of the year's growth. Lytchett Bay still shows increase. South of Poole, at Hospital Island, the increase is rapid. Near the Harbour's mouth the same sluggish growth continues. Crossing to South Haven, from Bramble Bay to Redhorn Quay, only very slight growth is noticed, while onward to Newton Bay and Goathorn it is again rapid.

LIST OF RARE OR UNCOMMON BRITISH PLANTS FOR THE DISTRICT.

Collected during the Season of 1916, mostly in the Isle of Purbeck, by C. B. GREEN.

Lon. Cat. Ed. 10.

71 *Fumaria Boraei*, Jord. *officinalis*, L. (hybrid)

74 *F. officinalis*, var. *Wirtgeni*.

* For references to the literature of the subject see the Reports for 1913-14 and 1914-15, Volume VII., page 42.

- 86 *Barbarea arcuata* Ait.
 89 *B. verna* (*praecox*), Aschers.
 162 *Crambe maritima*, L. (An old record).
 202b *Silene latifolia*, R. & B. var. *puberula* (Jord.)
 212 *Silene noctiflora*, L.
 268 *Spergularia rupestris*, Lebel.
 290 *Althaea officinalis*, L. (Miss Rooke).
 313 *Geranium pratense*, L.
 349 *Trigonella ornithopodioides*, D.C.
 375 *Trifolium suffocatum*, L. (and Alderman Gardner).
 387 *Lotus tenuis*, W. & Kit.
 390 *L. hispidus*, Desf.
 705 *Eryngium maritimum*, L. Rediscovery (and Miss Rooke).
 920 *Arnoseris minima*, S. & Koerte (and Rev. E. Ellman).
 1126 *Monotropa Hypopitys*, L. (and Ald. Gardner).
 1184 *Anchusa sempervirens*, L.
 1219 *Verbascum Blattaria*, L. (and Miss Rooke).
 1302 *Orobanche amethystea*, Thuill. (and R.V.S.).
 — *Utricularia ochroleuca* (*vide* Dr. Moss) (and R.V.S.).
 1552 *Orchis ustulata*, L. Rediscovery.
 1598 *Asparagus maritimus*, Mill.
 1667 *Sparganium neglectum*, Beeby (*vide* Rev. E. F. Linton).
 1693 *Potamogeton alpinus*, Balb. (new stations).
 1693 *P. alpinus* Balb., *lucens* L. (hybrid), *vide* A. Bennett, A.L.S.
 See "J. of B.," Oct., 1916, New to Britain.
 1711 *P. pusillus*, L. type, and vars. *tenuissimus* and *ligulifolius* (near).
 1716 *P. interruptus*, Kit.
 1724 *Zostera nana*, Roth. (abundant in Poole Harbour this season).
 2072 *Nitella translucens*, Agardh (new station).

Gall (new to Britain).

Eriophyes ononides, on *Ononis repens*.

See "J. of B.," Jan. and June, 1916.

Entomological and Zoological Sections.

CHAIRMAN : F. G. PENROSE, M.D., F.R.C.P., F.Z.S.

SECRETARIES : (Entomological) Miss M. C. VEALE.

(Zoological and Microscopical) : H. B. WELLS, F.R.M.S.

It has been considered advisable to carry on these two Sections separately for the present so as to make as few changes as possible during the abnormal period in which we are now living.

The Sections have, however, practically joined forces at their meetings.

There were two meetings in the afternoon, one of which was in connection with the Photographic Section.

In the evening in the Entomological Section papers were read and demonstrations given by Mr. Omer Cooper, Mr. Neale and Mr. W. Parkinson Curtis.

There was one excursion to Swanage in conjunction with the Geological Section on June 29th to visit the breeding haunts of the sea birds breeding on the cliffs near Durlstone Head and to collect butterflies, moths, etc., in the fields beyond the Lighthouse at Anvil Point. The members of the Geological Section, under

the guidance of their Chairman, Mr. Munn Rankin, examined the strata of the Portland and Purbeck beds between Durlstone Head and Peveril Point.

Entomological Section.

Annexed is a report by two members, Messrs. W. Parkinson Curtis and E. Harker Curtis, on the progress they have made in arranging the birds' eggs in the Batley Collection.

F. G. PENROSE.

Report on the Batley Ornithological Collection by Messrs. W. Parkinson Curtis and E. Harker Curtis.

We had during 1915-16 Session a nearly completely uninterrupted year at this collection and almost without exception devoted three to four hours every Thursday night to it.

The delay in delivery of boxes on the part of the makers and the absence of proper cabinets militated against speedy work somewhat. We have, however, procured for the temporary housing of the collection some chests of drawers very cheaply, and whilst these do not lend themselves very well to a nice display of the specimens they at any rate ensure reasonable safety for the collection and some degree of accessibility. We have now dealt with 1,030 eggs and have, we are glad to report, been able on many occasions to trace the history of the eggs and satisfy ourselves that the data we have attributed to them are correct. Identity checking is not, of course, entirely satisfactory, but the catalogue raisonné which we have compiled gives a very clear idea of the rules by which we have guided ourselves.

Every egg has been measured for axis and diameter in centimetres carried to two places of decimals.

The distribution of the eggs we have so far dealt with is as follows:—

Ardeiformes			
Ardeidae	...	16	
Ciconidae	...	2	
Plataleidae	...	1	
Ibididae	...	3	
		22	
			22
Alciformes			
Alcidae	...	147	
			147

Accipitriformes			
Falconidae	...	55	
Vulturidae	...	4	
Pandiones	...	2	
		61	
			61
Anseriformes			
Anatidae		43	
			43
Coraciiformes			
Alcedinidae	...	5	
Coraciidae	...	3	
		8	
			8
Columbiformes			
Columbidae	...	16	
			16
Colymbiformes			
Colymbidae	...	4	
			4
Charadriiformes			
Charadriidae	...	87	
Glareolidae	...	1	
Otididae	...	1	
Parridae	...	3	
Oedicnemidae	...	2	
		94	
			94
Galliformes			
Phasianidae	...	33	
Megapodidae	...	1	
Numididae	...	1	
Tetraonidae	...	9	
		43	
			43
Lariformes			
Laridae	...	128	
Stercoraridae	...	6	
			134
Passeriformes			
Fringillidae	...	156	
Dicuridae	...	23	
Sylviidae	...	4	
Zosteropidae	...	1	
Sturnidae	...	34	
Oriolidae	...	5	
Icteridae	...	16	

Ploceidae	...	36	
Corvidae	...	69	
Tyrannidae	...	1	
Tanagridae	...	7	
			352
Podicipediformes	...	21	
			21
Phoenicopteriformes	...	3	
			3
Procellariiformes			
Procellariidae	...	5	
Puffinidae	...	4	
Pelicanoididae	...	1	
		10	
			10
Pelicaniformes			
Phalacrocoracidae	...	4	
Sulidae	...	3	
		7	
			7
Pteroclidiformes	...	1	
			1
Rheiformes	...	1	
			1
Ralliformes			
Rallidae	...	43	
			43
Strigiformes			
Bubonidae	...	16	
Flammeidae	...	2	
		18	
			18
Struthioniformes	...	1	1
Tinamiformes	...	1	1

1030

We estimate that we have now dealt with one-half of the total collection, and we may say that we are satisfied that the Society has procured full value for the price it paid for the collection in the condition it was in when purchased, although our estimate of number was in excess of the actual number according to our present more detailed information.

It is perhaps stating the obvious when we say that arranged in boxes as it is to-day and duly catalogued, and as we hope to complete the collection, its value is enhanced both commercially and scientifically and the collection should be of value to students.

Of course there are numerous blanks, and any collection of authenticated clutches with full data, taken by a reliable collector, would be an acquisition.

The system we have adopted lends itself to indefinite expansion without causing confusion, so that any member of our Society who likes to present to it authenticated clutches will have the satisfaction of increasing the scientific interest of the collection as a whole.

W. PARKINSON CURTIS and E. HARKER CURTIS.

14th September, 1916.

Geographical Section.

CHAIRMAN: CLAUDE LYON.

SECRETARY: W. J. WOODHOUSE, A.C.P.

The Section sustained a loss in the resignation through ill-health of Dr. de Castro, who, as Chairman for some years, had done much to further the interests, not merely of the Geographical Section, but of the Society as a whole.

Since the present Chairman had the honour to be elected to fill Dr. de Castro's place the sectional meetings have continued to be well attended. The number of lectures has been up to the average. The successful working of the Section has been largely due to the valuable co-operation of the Hon. Secretary, Mr. Woodhouse.

The interest taken in the summer excursions, as shown by the number of members who took part in them, is very gratifying to the Chairman.

A work, which it is hoped will be, when completed, of some importance to the Society, namely, the making of a relief map of the district, has now been initiated.

C.L.

Geological Section.

CHAIRMAN: W. MUNN RANKIN, M.Sc., B.Sc.

The work of the Geological Section was carried on during the year with little interruption, and, if anything, with increased vigour. The attendance at the meetings was well maintained. No noteworthy additions to the collections were, however, made. Two or three excursions only were undertaken: the railway and char-a-banc restrictions hindering field work on any extended scale.

W.M.R.

Photographical Section.

CHAIRMAN: R. Y. BANKS.

SECRETARY: EDWIN DODSHON, LL.B.

Notwithstanding the restrictions on photography due to the war, much good work has been done by the members of the

Section, indeed more records have been taken than in any previous year. Many lantern slides have been produced, not only in connection with the record work, but also for the illustration of various lectures, both general and in practically every section. The number of slides owned by the Society is now over 1,000, and the Chairman has carried out the classification and arrangement of these on a plan which should make them readily available for future use. Only one Photographic excursion was held during the summer, this being to Heron Court, but the members were very active at the various other outings, Bloxworth Manor, Woodsford Castle and Lulworth Castle being dealt with in a very comprehensive way. Some independent work was done by the Chairman and the Secretary, by the former at Corfe and Swanage and by the latter on old fonts from the churches round about Bournemouth. Some interesting old doors at Poole were sent in by Mr. Shervey, and copies of old photographs taken in 1878, lent by Mr. Baker, were reproduced by the Chairman.

R. Y. B.

Physical Section.

CHAIRMAN: HUBERT PAINTER. B.Sc., F.C.S.

SECRETARY: E. W. BARLOW, B.Sc., F.R.A.S.

During the latter part of the session Mr. Barlow went into training for a branch of His Majesty's service, and Mr. Henry Le Jeune very kindly undertook the duties of Secretary. The marked success of the excursion on July 11th was due to the admirable arrangements which he made.

The many members who heard the notable lecture on "The Study of Splashes" will have learned with regret of the death of the lecturer, Professor Worthington.

It is with pain that I have to record the death, in the service of his country, of Captain Gerald Henry Sullivan, Royal Marines, who was formerly a member of the Society and lectured at a joint meeting of the Geographical and Physical Sections on January 20th, 1912.

H. P.

The late Wilfrid Omer Cooper, F.E.S.

THE Paper printed below was prepared by the late W. Omer Cooper with the intention of reading it before the Zoological Section. The author's name was inscribed on the roll of Honour before this intention could be carried out. The Council has resolved that the paper, and the prefixed "appreciation," should appear in the Society's Proceedings as a tribute to the memory of a member who found time, in his short life, to do real service to the Society and to zoological science.

HON. ED.

Private Wilfrid Omer Cooper.

An Appreciation.

All war is waste, we are reminded by a Minister of State, and in no sense is this more true than in the destruction of young lives of high intellectual promise. The rolls of honour of the Universities and Public Schools are largely lists of men whom the State can least spare, and whose deaths are a double loss—a deprivation of manhood, and of what is no less important, character and intellect.

Private Wilfrid Omer Cooper joined a Bankers' Battalion of the Royal Fusiliers early in the present year (1916), went to France in August,—and was reported "missing" with many others on September 26th, after an attack on Thiepval. Much more than this, however, is to be said of W. Omer Cooper. He was, though yet young, being in his 21st year, a student of science who was rapidly approaching the dignity of master in the narrow, circumscribed branch of research he had made his own. He was a keen and accurate observer in zoology, and, without the advantages of that training only to be acquired in the lecture-rooms and laboratory of a University, had accomplished much work that was of a high order. His particular study was the Isopods, a group of crustaceans, some land, most marine, popularly best known as common wood-lice. He added two new species to the British Fauna, *Heterotanaïs oerstedii* and *Clyponiscus hansenii*, besides contributing a large number to the already published Hampshire lists. As earnest of the considerable volume of work which promised to issue from his pen, he contributed several papers to zoological journals. Among these were the following:—

"Woodlice" in the Proceedings of the Bournemouth Natural Science Society.

"Notes on the Occurrence of *Heterotanaïs oerstedii* and other Isopods in Christchurch Harbour," in collaboration with his brother Joseph, in "The Zoologist" of January, 1916.

"On *Paragnathia*" in "The Annals and Magazine of Natural History" of July, 1916.

"On some Undescribed Features in the Structure of *Cyathura carinata*," in "The Journal of Zoological Research" of October, 1916.

As a recognition of his scientific attainments, and as an encouragement to the great promise of his mind, he received, as soon as he was eligible by age, the great honour of admittance to the Linnean Society, being proposed by the Rev. T. R. R. Stebbing, F.R.S., one of our foremost zoologists. Such an honour is given cautiously, and only to well-qualified persons, and rarely if ever has it been conferred upon one so young.

Nor were his interests confined to science. In his versatility he was a student of the local gipsy life, added two or three new words to the Romany language, and was at one time a member of the Gipsy and Folk Lore Club. Further, he was endowed with a

keen and delicate artistic sense, joined to a ripening talent in literary expression. The same week-end that he was reported missing an article on Mudeford written by him appeared in the "Saturday Review." In a subsequent number, the editor, G. A. B. Dewar, himself a careful naturalist and a lover of Hampshire, paid this tribute to his memory:—"We are sorry to hear that among the missing in France last month was Private Cooper, author of the wistful and beautiful little paper "At the Fishing Village," printed in this Review on September 30th. The artist and naturalist met and harmonised in him—if we must put it thus in the past tense. The scene he described—Mudeford and Hengistbury, and the strange withy wood nestling close to the side of the huge sand and mud headland, with the Norman Priory and the gleaming estuary—is of haunting loveliness at all seasons. One recalls a wonderful page from Richard Jefferies: 'They go on without me.' "

W.M.R.

Some Rare and Interesting Local Isopods.

W. OMER COOPER, F.L.S.

SOME time ago I gave a short lecture on the local species of terrestrial Isopoda or Woodlice, and it is now my intention to give you some account of the more interesting marine Isopods which occur in the Bournemouth district. It can hardly be said that any of the marine species belonging to this group are well known to the general public, but at the same time a few species make themselves more or less conspicuous on account of the damage which they cause, a good example being the Fish-lice, which often attack cod and other fishes in incredible numbers and are consequently of no little economical importance. Again, the destruction of the piles of piers which is so noticeable at Totland and other places around here is largely caused by an Isopod—*Limnoria lignorum*, or, as it is called in some places, the Gribble—while the strange parasitic Isopod Bopyrus is the cause of the familiar swellings often seen on the heads of prawns, and workers on other groups of Crustacea are usually well-acquainted with some of the peculiar and misshapen parasites belonging to this order. It is not, however, the most conspicuous and well-known species which are of the greatest interest and I am treating my subject from the zoological, rather than the economical, standpoint, as in this way I hope to touch upon most of the more interesting features of the local species.

The marine Isopoda do not show that uniformity of structure which, more especially as regards the appendages, is such a feature of the terrestrial species. They are all more or less dorso-ventrally flattened, but at the same time they present almost every type of body and of appendage known among the Crustacea, for they vary

from the worm-like members of the family Anthuridae to the round-bodied slender legged form—such as *Munna*—found among the Asellota and to the strange misshapen parasites of the sub-order Epicaridea, many of which show no signs whatever in the adult form of their Crustacean affinities. It seems strange indeed to see Crustaceans, belonging to such a highly developed order as the Isopoda, without head, without legs, and without internal organs, a mere sack of eggs almost incapable of movement, but there can be no doubt of the relationship of these forms. A very large number are parasitic in habits, including the whole of the Epicaridea and a large number of the Cymothoidae, while the Gnathiidae are also parasitic during the larval stage.

The species of which I am going to speak are, for the most part, inhabitants of the shore line, but at the same time a large number of deeper water forms are to be found in various parts of the English Channel, and can often be obtained from the fishermen, who in many cases are only too familiar with species of Fish-lice belonging to the immense family Cymothoidae. My records for the Bournemouth area do not, however, include any species which is not to be taken in comparatively shallow water.

There are in this district three well defined groups of hunting-grounds for marine Isopods:—The brackish waters of Christchurch Harbour and of the lake in Poole Park; the rocky coast from Totland round the Needles to Freshwater Bay and at Studland and Swanage; and the various local piers. In addition, two species belonging to the genus *Eurydice* are to be found along the sandy shores at Boscombe, Swanage, etc.

Of course, the most easily available collecting grounds—and therefore those which most appeal to myself and the other not-too-energetic zoologists of the district—are the piers at Boscombe and Bournemouth, but, as might be expected from the nature of the sea-bottom, these are not nearly so productive as those at Swanage and Totland. I have, however, taken one very interesting Isopod on Boscombe Pier and one which, so far as I can discover, is entirely new to the British Fauna. This is *Clypeoniscus hansenii* (Giard and Bonnier), a species formerly recorded from Denmark and from Greenland and described and figured by Prof. Sars in Part II. of his "Crustacea of Norway": it is parasitic within the brood-pouches of *Idoteas*, which, strangely enough, are also Isopods, this being one of the rare cases of an animal parasite on another member of the same order. The species on which I have taken it is *Idotea pelagica*, the first record of the parasite from this particular host. I may mention that this *Idotea* is one of the commonest Isopods in this district and is very plentiful among the mussels on Boscombe Pier. The female of *Clypeoniscus* is about 4 millimetres long and is of a flattened and roughly oval form: it is one of the most remarkable examples of degeneration with which I am acquainted as it consists of a mere sack of eggs without head and without appendages, its only functions being to absorb the juices of its host and to develop the eggs which occupy

the whole interior of the body. It has, in fact, had all the trouble of evolving from the primitive Metazoic type only to find that it might have just as well remained in its original lowly condition for all the good that its highly developed structures have been to it. This species is an example of the very interesting zoological phenomenon of "protandrous hermaphroditism," the animal being first an active male and afterwards a sedentary female. In other words the male is simply a larval stage of the female, presenting many of the original characters possessed by the Isopod before it fell into its debasing parasitic mode of living. This condition is found in very few animals and presents to the student of sex many interesting and intricate problems of wide application. The male, or late larval stage, of *Ciypeoniscus* is much smaller than the female, being only about one millimetre in length: it shows many signs of degeneration for it has lost its eyes, its mouthparts are reduced to a mere oval cone, and its antennæ function as grasping organs—being flattened and provided with large teeth with which to hold on to its wife—but it still retains the majority of its appendages, and is evidently capable, to some extent, of an independent and active existence, though to a much less degree than are most of the members of its family, the Cryptoniscidae. Unfortunately, I have so far been able to procure only one specimen of each sex, although I have no doubt that a little search among the mussels on Boscombe Pier would result in the capture of further examples. The female which I have was full of half-developed embryos, but these do not show the peculiar plate covering the underside of the abdomen, which is found in the larvae of this species and from which the genus takes its name. The *Idotea* which had the misfortune to have its internal arrangements disturbed by this strange pair had turned quite yellow, though what was the cause of this coloration I could not say: probably the damage done to the creature's anatomy by the parasites affected its power of colour-secretion.

Another Isopod new to the British Fauna which I took last year is *Heterotanais Oerstedii* (Krøyer), a species belonging to the very aberrant group Chelifera. These Isopods—if indeed they should be classified among the Isopoda at all—are well distinguished by their lobster-like pincers and by various other anatomical features: they are represented in this district by *Apseudes Latreilli*, *Tanais tomentosus*, *Leptochelia Savignyi*, and this species. I have found *Heterotanais* very plentifully in Christchurch Harbour among the mud and algae on the surface of the stones lying in the shallow water near the shore, where it may easily be picked out on account of its white colour. It is about three millimetres in length and the male is remarkable for the extraordinary size of its pincers or chelae, which seem out of all proportion to the size of the poor little creature which has to carry them about with it: they are imperfectly chelate and the thumb consists of quite a thin plate so that it is somewhat difficult to see of what service these appendages can be to this tiny quaint-

looking Crustacean. The female has the chelae of normal size and form, and is altogether a more presentable object than the male: so much so in fact that the two sexes have in more than one instance been described as belonging to two quite distinct species. I have found the females rather more plentiful than the males, as Prof. Sars states to be the case in Norway. Both sexes are very sluggish in their habits and are by no means difficult to capture. If mud containing these Isopods be put in a bowl of sea-water and stirred up they will be found in dozens floating on the surface film almost without movement and may easily be picked out with a brush or pipette. It is impossible to describe the habits of an animal which does not possess any, but it may be stated that *Heterotanais Oerstedii* so far exerts itself in its native haunts as to burrow in the mud. The young emerge at the beginning of August and appear to be quite as lazy as their parents, though at that time of year such a disposition is more or less excusable. My identification of my specimens was confirmed by the Rev. T. R. R. Stebbing, the well-known author of several famous works on the Crustacea. A very closely allied species, *Heterotanais Gurneyi* (Norman) has been recorded by Mr. R. Gurney from the coast of Norfolk: both appear to be essentially brackish-water species.

In addition to this Isopod two other very interesting members of the Order are to be found in Christchurch Harbour, each of which has been recorded from only two other localities in the British Isles. The first of these is *Cyathura carinata* (Kröyer), a slender, almost worm-like, creature about three-quarters of an inch, or 18 mm., in length, and of a whitish colour, marked along the back with brown. It belongs to the family Anthuridae, so called from the "flower-like" appearance of their tails, which are partly covered by the overarching uropods, from which feature also arises the name *Cyathura*, "cup-tailed." This Isopod, although very rare in this country, is well-known to students on account of the work done on its anatomy by German scientists, though, strange to say, no proper description of the male appears to have been published. *Cyathura* is remarkable as being the only Isopod, with the exception of the closely related *Anthura gracilis* (Montagu), which possesses statocysts, and a well-known paper giving a detailed description of these structures has been written by Prof. Thienemann, who has, however, confused this species with *Anthura gracilis*. The statocysts, a pair of which, each containing a single statolith, are situated in the anterior part of the telson or tail, are, presumably, for the purpose of showing the direction of the force of gravity, but they seem rather out of place in a species which, although of fairly active habits, spends its life burrowing in the mud and is very rarely seen swimming. No explanation of their occurrence in this particular species has so far been brought forward, and it is only by a long and painstaking study of its habits that we can hope to solve the problem. Strange to say its mode of life is in almost every way different from that of *Anthura gracilis*, the other species possessing statocysts. The female of

this latter Isopod would appear, in some cases, at any rate, to occupy the empty tubes of the sea-worm *Sabella*, and with its peculiar tail protruding to imitate the head of the former tenant, the male, which is exceedingly rare, is pelagic in habits and is no doubt of a very inconstant disposition, roaming from place to place and courting any lady of his own race whom he may come across. His antennae are tremendously produced and are provided with numerous sensory hairs, which doubtless assist him in discovering brides. As opposed to such a frivolously disposed creature as this, the male of *Cyathura* is almost exactly similar to the female, with which it lives in harmony in its muddy home. I have found them in considerable numbers along the shore of Christchurch Harbour, most frequently under stones and burrowing in the mud, the tail being often exposed above the surface of the mud for breathing purposes. Males and females are in almost equal numbers, and I have had the young emerge from the brood-pouch at the beginning of August. They are good swimmers, bending their bodies and using their abdominal appendages as organs of propulsion, but it is improbable that under normal conditions they often leave the mud. As is the case with many Isopods it is very difficult to discover upon what this species feed, but it is probable that its food consists principally of organic particles contained in the mud in which it lives: its mouth-parts are to some extent modified for suction, but at the same time there is nothing whatever to incline one to believe that it is in any way parasitic in its habits. Upon making dissections of the male I discovered a very peculiar structure in the sexual stilet, which, as in most other Isopods, is found attached to the inner branch of the second abdominal appendage. This, instead of being a simple rod, as in the case in all other Anthuridae, and, in fact, wherever the stilet occurs among the Isopoda, terminates in two large lobes, standing out at somewhat of an angle to the main stem of the organ, from one of which springs a slightly curved rod furnished at its extremity with a crown of large reflexed teeth. I have referred this structure to the Rev. T. R. R. Stebbing, to Dr. Calman, of the British Museum, and to other authorities on Crustacea, but I can hear of no analogous structure in any other Crustacean, nor have I so far discovered the use of this strange sexual organ. It would seem probable, however, that so marked a divergence from the usual type is of considerable importance from an anatomical standpoint, and I am hoping to work out the matter more fully before long. It is somewhat remarkable that the anatomy of the male *Cyathura* has never previously been examined in a proper manner. I may mention that among other interesting features this is the only member of the family which has the abdominal segments fused together in the male.

The other interesting Isopod which occurs in Christchurch Harbour is *Paragnathia Halidaii* (Bate and Westwood), a small and little-known species belonging to the important family Anthuridae. In the larval stage this species, like others belonging

to the Gnathiidae, is parasitic upon the bodies of fish, the hosts usually chosen by *Paragnathia* being the small flat-fish, which are frequently so common in brackish waters. This larva, or as it is generally termed, the praniza, unlike the adult, has the mouth-organs present in the normal number and adapted for piercing and sucking, forming a sharp oval cone, which the parasite plunges into the body of its host, clinging to the skin of the latter by means of the strong claws of its first pair of legs. It is nourished by the juices of the fish to such an extent that the middle of its body swells up to a large size and provides the animal with a considerable reserve store of food. When full-grown the praniza relinquishes its victim and makes its way to the shore, where it casts its skin and assumes an adult form utterly different from the one which it has just discarded. I came across large numbers in the act of changing their form at the beginning of May in last year: the pranizas were particularly striking on account of their vivid coloration, most of them being of a brilliant yellow or orange occasionally shading into brown, whereas the adults are of a uniform grey or dirty white shade. In the adult stage this crustacean is particularly terrestrial in habits, being found in small cavities in the banks just below high-water mark, where a number of specimens are usually found together, the males apparently having small holes leading from these cavities into which they retire in case of danger. They are very sluggish in their habits, and when frightened frequently sham death, folding the legs along the body. Strange to say, when they reach the adult state, these animals appear to have solved the great problem of our existence, how to live without eating, and it seems probable that, like the members of the related genus *Gnathia*, they can live for several years entirely without food, and without the trouble and exertion of taking a single meal during the year. The female has no internal organs whatever save a nerve-cord, the whole body-cavity being occupied by the eggs or developing larvae, but, unlike *Clypeoniscus*, its legs and other appendages, with the exception of the mouth parts, are well-developed, and it leads a perfectly independent existence. It is a strange looking object, as the middle of its body is immensely distended and perfectly transparent, while the head and tail are so small as to be hardly noticeable, and one always expects it to collapse with a squeak like one of these inflateable pigs which so delight small children. The male is of a much more compact build, but is remarkable for the size of its head and its fierce-looking, though apparently almost useless, mandibles, the whole affair giving it a top-heavy appearance. It has the mouth-parts of a very peculiar structure, which it is almost impossible to describe accurately without the use of illustrations: they are very widely separated in structure from those found in the members of the genus *Gnathia* in which this species was formerly placed, and I have, therefore, transferred it to a new genus to which I have given the name *Paragnathia*. It is very closely related to *Euneognathia*, a genus created by Mr.

Stebbing to receive the deep-water species *Anceus gigas* (Beddard); the chief differences between *Paragnathia* and *Gnathia* lie in the 5-jointed gnathopods found in both sexes of the former and in the absence of maxillipeds in the female. I have found this very interesting Crustacean exceedingly plentiful in the banks of Christchurch Harbour throughout the summer and autumn, but I am inclined to think that the females die after releasing the larvae from their body-cavities, and that many of the males are killed off during the winter.

The only other brackish-water Isopod of any interest which occurs in this district is *Idotea viridis* (Stabber), a species which is very plentiful in the lake in Poole Park. It is by no means a common animal in most parts of the country, and is noteworthy on account of its singularly beautiful and protective colouration. It lives among the delicate green Algae which are so plentiful in the lake, and by its pure green colour and extraordinary transparency renders itself almost invisible, and it is by no means an unusual thing to pass over several of these pretty little creatures when actually searching a piece of weed for them. The male and female are, for some inexplicable reason, of quite different shades of green and are also distinguished by the general form of the body to an extent not usually found among the members of this family. A very good description of this species is given by Prof. Sars in his "Crustacea of Norway," in which book there are also fine illustrations of both sexes.

Numerous other species of Idoteidæ are found in this district, but none of them is of any particular interest. *Zenobiana prismatica* is a rather scarce species found in Studland Bay and at Totland, the genus being distinguished from *Idotea* by an additional free segment in the abdomen. *Idotea linearis*, a somewhat common species which I have taken crawling up the ropes attached to lobster-pots around Freshwater Bay, frequently reaches $1\frac{1}{4}$ inches (31 mm.) in length excluding the antennae, which are themselves often quite an inch (25 mm.) long. Mr. W. E. Collinge, of St. Andrew's University, who has just written a very full revision of the British Idoteidae, tells me that he believes there is an undescribed species of *Synisoma*, one of the genera of the Idoteidae to be found along this coast. Closely related to these Isopods and belonging to the same sub-order—the Valvifera—is *Astacilla*, the "little lobster," which occurs in Totland Bay. This weird-looking little creature lives among coralines, and is peculiar for its prehensile antennae to which its whole brood of young ones cling, and strange indeed it looks, sitting bolt upright on its hinds legs, as is its custom, with a dozen babies hanging on to its unusual head-gear.

On the rocks perhaps the most noticeable Isopods are the various members of the family Sphaeromidae—*Sphaeroma*, *Dynamene*, and *Cymodoce*—which have the power of rolling themselves into balls after the manner of certain well-known woodlice. When in this condition they are often very difficult to secure, as they will

roll into the smallest crevices from which it is almost impossible to extricate them on account of the smooth slippery surface which they present to the collector. Much trouble in the identification of species in this family has been caused by the extraordinary differences which exist between male and female, and young and adult, in the same species as well as by the large number of variations found, but, fortunately, we have, in Dr. Hansen's paper on their family, a sure guide through the bewildering maze of sexual, larval, local and other forms. The Gribble, *Limnoria lignorum*, which I have mentioned before, belongs to this family, and is undoubtedly the most interesting of the local Sphæromidæ. It is particularly plentiful in the woodwork of Totland Pier, where, together with the notorious Amphipod *Chelura terebrans*, it does an incredible amount of damage to the piles: in its company in the holes in the woodwork are found two other Isopods, *Tanais tomentosus* and *Leptochelia Savignyi*, but it is improbable that these are active agents in the destruction of the timber. The Gribble is a small whitish Crustacean about 5 millimetres in length and a little over 1 in breadth: like most of the members of its family it is capable of rolling itself into a ball and its body and appendages are strongly and compactly formed to aid it in its boring habits. It is strange to think of the amount of damage caused by such a seemingly insignificant creature and to watch it at work on the woodwork of a pier one is half inclined to let one's imagination run riot and to believe that the Gribble realizes the result of its labours and enjoys the thought of the destruction which it is causing. Various methods of warding off the attacks of *Limnoria* have been tried, such as treating the piles with pitch and similar preparations, but none have proved of any great success, for the Gribble is more powerful than we are and still costs this country some hundreds of pounds each year in repairs to woodwork exposed to its attacks.

I have prepared a list of the local marine and fresh-water Isopods which I am asking the Secretary to publish in the next report of our Society, but this must be for the present an essentially preliminary affair. I am greatly indebted to Mr. H. J. Waddington, F.L.S., for his permission to quote his records, which have been of the utmost value to me in my preparation of this list, but, at the same time, I am confident that if I had the time and opportunity to make a thorough examination of the collecting grounds in this district I could very largely increase my present number of records, more especially as regards the parasitic Isopods belonging to the sub-order Epicaridea. I am convinced that this district is very rich in marine Isopoda, but it would require several years' work to make anything like a complete list of the species occurring in the neighbourhood.

I do not think that the Isopoda are a group which lend themselves so much to faunistic studies as to general classificatory and anatomical work, but at the same time Prof. Sars' volume on the Isopoda of Norway shows what may be done with this subject

even from the faunistic and speciographic standpoint. Of course, many of the foreign species appeal very strongly to the imagination as, for instance, in the family Cymothoidae, *Glossobius*, which spends its life attached to the tongue of the Flying-fish and *Ega spongiophila*, which inhabits the beautiful glass-sponge *Euplectella*, popularly known as Venus's Flower Basket. Then there are the species found in caves and in wells or parasitic on fish inhabiting mountain streams far away from the sea; the strange deep-sea forms such as the gigantic *Bathynomus* which reaches nearly eleven inches in length by five in breadth, or the extraordinary spider-like creatures belonging to the sub-order Asellota; the Australian *Eisothistos*, which not only lives in the tube of a sea-worm, but accurately mimics the original occupant; and the primitive Phreatoicidae, which are relics of an otherwise long extinct group. But in spite of these attractive types, the Isopoda found in the British Isles are as representative and extensive a collection of forms as are found in any country in the world, with the possible exception of the Scandinavian Peninsula. They include not only representatives of almost every known family of the Isopoda, but examples of almost all the peculiar forms such as those found amongst the parasitic Epicaridea, etc. In all there must be well over a hundred terrestrial and littoral species found in and around these islands, and this number is being added to every year, while there is a vast amount of work yet to be done on the anatomy and habits of our native species. As I have mentioned before, many of the species are of considerable economic importance and their study is consequently of practical service, while for the zoologist a more interesting group of animals could not be found. Many of the species may be obtained by shore collecting or by scraping piers, though a fair number require the use of the dredge and provide one with those most pleasant of all excursions—dredging expeditions. I have given up recommending the use of the townet since I found myself a prisoner in the guard room of Freshwater Fort as the result of practising this form of collecting in the Bay. Whether I was suspected of taking soundings I cannot say, but I was finally dismissed "without a stain on my character," though a sadder and a wiser man. A good plan is to interest local fishermen in the subject and to offer them a small amount for any specimens of Isopoda which they secure: in this way I have obtained excellent specimens of such types as *Bopyrus*, which although fairly common are somewhat troublesome to procure in the ordinary course of events.

As regards books on the subject the three which give the fullest account of the British species are Bate and Westwood's "British Sessile-eyed Crustacea," Stebbings' "Crustacea," in the International Science Series, and Sars' "Crustacea of Norway," volume 2. Dr. Calman's volume on the Crustacea in Ray Lankester's "Treatise on Zoology" is the standard work on the general classification and anatomy of the group. Practically all the other work on our native Isopoda is recorded in scattered

papers, many of them being in the Linnean Society's publications.

Fortunately there are a fair number of scientists at the present time working on this Order, but there is still much to be done. It is to be hoped that workers on local natural history will devote a little of their time to the Isopoda and in this way some of the many problems which confront the student of this group may be solved.

PRELIMINARY LIST OF THE MARINE AND FRESH-WATER ISOPODS RECORDED FROM THE BOURNEMOUTH AREA.

W. OMER-COOPER, F.L.S.

SUB-ORDER, CHELIFERA.

Family, *Apseudidae*.

Apseudes latreilli ... Studland Bay.

Family, *Tanaisidae*.

Tanais tomentosus ... Totland, Swanage.

Leptochelia savignyi ... Totland.

Heterotanais oerstedii ... Christchurch Harbour.

Paratanais batei ... Poole Harbour.

SUB-ORDER, FLABELLIFERA.

Family, *Gnathiidae*.

Gnathia maxillaris ... Totland, Swanage.

Paragnathia haliidai ... Christchurch Harbour.

Family, *Anthuridae*.

Cyathura carinata ... Christchurch Harbour.

Family, *Cymothoidae*.

**Eurydice pulchra* ... Brook, Swanage.

„ *spirigera* ... Swanage.

Family, *Sphaeromidae*.

Sphaeroma serratum ... Freshwater and Alum Bays, Swanage.

„ *rugicauda* ... Christchurch Harbour.

Cymodoce truncata ... Totland, Studland Bay.

Naesa bidentata ... Freshwater and Alum Bays.

Limnoria lignorum ... Totland.

SUB-ORDER, ASELOTA.

Family, *Asellidae*.

Asellus aquaticus ... Ditches and ponds throughout the district.

Family, *Parasellidae*.

Jaera marina ... Freshwater and Alum Bays, Swanage.
Poole Harbour.

**Munna kroyeri* ... Swanage.

SUB-ORDER, VALVIFERA.

Family, *Idoteidae*.

Zenobiana prismatica ... Totland. Studland Bay.

Idotea linearis ... Freshwater Bay.

„ *pelagica* ... Boscombe Pier.

„ *battica* ... Totland.

„ *granulosa* ... Freshwater and Alum Bays.

„ *viridis* ... Lake in Poole Park.

**Stenosoma acuminata* ... Bournemouth Bay.

Family, *Astacillidae*.

**Astacilla longicornis* ... Totland Bay.

SUB-ORDER, EPICARIDEA.

Family, *Bopyridae*.

Bopyrus squillarum ... Mudeford (on *Palaemon serratus*).

Family, *Cryptoniscidae*.

Clypeoniscus hansenii ... Boscombe Pier (on *Idotea pelagica*).

OTE.—For the records of the five species marked with an asterisk I am indebted to Mr. H. J. Waddington, F.L.S.

A Selection from the Papers read before the Society.

Eucalyptus and other Australian Plants Acclimatised in and around Bournemouth.

By SIR DANIEL MORRIS, K.C.M.G., M.A., D.Sc., F.L.S.

(Delivered as a general Lecture at the Society's Room, March 18th, 1916).

NOTE.—This lecture was a sequel to the Presidential Address on “Hardy British Trees.” A full report of a similar lecture delivered before the Dorset Field Club is published in Volume XXXVII. of the Proceedings of that Club.

AUSTRALIA, a vast island continent in the southern hemisphere, is probably the oldest land-surface on the globe. Although the climate is, on the whole, remarkable for its dryness, yet, in the mountainous parts of New South Wales, Victoria and Tasmania the conditions approximate those of our own South Coast. The Australian fauna has marked peculiarities. The presence of a large number of marsupials is an outstanding feature. Of these the largest is the great grey kangaroo, while the platypus or duck-billed water-mole is the most remarkable. Among the birds are found the black swan, the white eagle, the emu and many species of parrots and cockatoos. The Moloch lizard is a singular reptile, while the flying gurnet is a beautifully coloured fish.

In studying the flora we are fortunate in having several local gardens where Australian trees and shrubs have been cultivated for many years. The widely-known Abbotsbury gardens contain the largest collection of such plants, but a very interesting, though much smaller, garden is that at Old Orchard, Broadstone, established by the late Dr. Alfred Russel Wallace, O.M.

Many Australian plants are to be found at Cuffnells, near Lyndhurst, and in the public and private grounds of Bournemouth itself. The plants which, by cultivation in these gardens and elsewhere in the neighbourhood, are accessible for our study, include many species of Eucalyptus or gum-trees and of Acacias or wattles. Besides these there are Grevilleas, Banksias and Hakeas, as well as many lesser known trees, shrubs and climbers. The total number of species of Australian plants acclimatised on the South Coast is probably not less than sixty.

There is a further reason for the careful study of the Australian flora as represented in this country. It has been asserted by some distinguished botanists that leaf remains of

Eucalyptus and other familiar Australian plants have been found in fossil beds contemporaneous with those of the Bournemouth Cliffs. This view has not been generally accepted. It is possible, therefore, that a close comparison of fossil remains with the living Australian plants accessible to us in this country may help to throw light on these and other problems.

The Church of S. Nicholas, Studland.

By THE REV. HENRY SHAEN SOLLY, M.A.

The following Paper is an expansion of some "Notes" read on the occasion of an excursion to Studland on May 27th, 1916. For additional matter I am much indebted to *The Architectural and Topographical Record*, and especially for permission to reproduce the ground plan and section herewith given. Arrangements for this, and for the photograph of the interior, have kindly been made by Mr. George Brumell, A.R.I.B.A. Some historical details are taken from Hutchin's *History of Dorset*, and much valuable information, especially in connection with the restoration of the building in 1881, is given by Mr. W. M. Hardy in *Proceedings of the Dorset Field Club*, Vol. XII., p. 164 seq, and reproduced by him in his *Old Swanage*, 1908.

OUR first notice of Studland is in Domesday Book. When Edward the Confessor was king, Studland was in the possession of Almar. At the time of the Survey it was held by Haimo in fee of the Earl of Moreton. A manor house must have stood here as Matthew Paris records two visits by King John. The advowson and manor passed through various hands, and in 1269 was conveyed to the Abbey of Tarent. Here it remained till the Dissolution; in 1546 Henry VIII granted it to Sir George de la Lynde; his successors sold it in 1582 to Sir Christopher Hatton, who ten years earlier had purchased the Castle of Corfe. After the death of Sir C. Hatton it reverted to the Crown more than once. James I granted it, 1617, to Nathaniel Rich, from whom it passed to Sir Edward Coke, and then by purchase to Sir John Banks.

Coming now to the building, it is hoped that what is here said will be useful to those visiting the Church, but it will be most interesting if carefully studied beforehand in connection with the Plan and Section. The "Twist," indeed, can only be seen in the Plan, the traces being now covered. With regard to the most interesting and tempting suggestion that the present Chancel was originally a Lady Chapel, we must bear in mind that this is a conjecture on which authorities are not agreed, and it presents difficulties as well as advantages which are noted at the end of this Paper.

The earliest building on the site of the Church was non-ecclesiastical, probably a Saxon Keep or look-out post held in connection with Corfe Castle or Wareham. Of this building some massive stone steps and the keystone of an arch have been found.

A Church building dates from early Saxon times and takes us back to a group of churches which are among the oldest in the country of which any substantial remains exist. St. Martin's at Wareham, and St. Nicholas at Worth Matravers are other Churches belonging to this group. So is the Church built by St. Aldhelm in the Seventh Century, though where this stood is uncertain; it may have been at Corfe Castle, or, more doubtfully, on St. Aldhelm's Head.

In Studland Church we have clear proof of pre-Norman work belonging to an earlier and a later stage. The foundations of the nave were originally laid so as to give the "twist" which was intended to indicate our Saviour's head on the Cross leaning to one side. This old foundation is 18ins. from the plinth at the N.W. outside corner, tapering off to nothing at the middle buttress of the tower. At the S.W. corner of the interior there is a similar divergence. In the present building there is no twist and the lines run straight to the end of the chancel, showing a change on the earlier design. But the main walls erected in accordance with this later design were in the first instance Saxon rubble work, and in them we have later insertions of Norman ashlar. The Norman work is apparently a little earlier than that of the Church at Iffley, with which, and with the one at Stewkley, it may be compared. If its date is approximately fixed for 1180, and that of the Saxon rubble work at shortly before the Norman conquest, which seems as near as we can get to the facts, then the earlier Saxon centuries afford ample time for the earlier constructions which appear to have taken place.

Extensive repairs were undertaken in 1880, and much was then discovered. It appeared that the ashlar, both inside and out, is a thin facing, 6-gins. thick, with no bond into the wall beyond. In many cases the interior rubble ran out as loose sand as soon as it had a chance. The clay on which part of the Church was founded had proved a favourite habitat for worms, and was perforated through and through by their burrowings. An added buttress was dragging down the wall it was meant to support, and on being taken down was found to be resting on a lead coffin whose sanctity had proved unequal to supporting the weight. Vaults and graves had been dug dangerously near, and even below, the level of the foundations of the chancel. The work of restoration was skilfully done, and has left us a building in which we can still trace the stages of construction.

In the eastern wall of the chancel there was probably no window of Saxon date, though a small Norman window, without decoration, was at some time inserted in the gable. The present Gothic window probably dates from Jacobean times. In the north

wall of the chancel we can see how Norman ashlar was inserted in the earlier Saxon rubble wall. Above the foundation there are 5 or 6 feet of rough rubble work, then comes a belt of ashlar into which a pure Norman window has been inserted. Above the window there is again rubble till the roof is reached, where there is more Norman work. The south wall of the chancel also shows earlier rubble and added ashlar. The angle quoins are Saxon. A moulded Norman window was converted into a doorway (there was no vestry), but in the Seventeenth Century it was restored as a window.

On the top of the north wall, near the tower, is a small doorway leading to the tower and to a priest's chamber over the chancel. The door would be reached by a ladder, and while there was no rectory the chamber would furnish accommodation for a travelling priest.

The exterior of the nave shows on the north wall a series of corbels carved in a way which indicates two stages, and, indeed, two different periods of civilization. The earlier, which are more weatherworn or are purposely defaced, show a want of refinement which is hardly credible. They are said to represent vices expelled from the Church, but if this was their meaning it was shown with a coarseness which was found intolerable. The later Norman carving shows designs of animals and flowers executed with much skill.

The south wall of the nave is mainly rubble work up to the eaves course. The porch is modern. On both north and south side there were originally two narrow Saxon windows, and Norman jambs and arches were inserted in the outside part of the window so that we now have two arches, one inside the other. The north-east window was cut through in the Eighteenth Century to give access to an inside gallery along the north side of the nave.

The west end seems to have been a plain Saxon wall, without window, rising to the eaves course. The gable has been rebuilt, and now carries a Maltese Cross.

The tower was begun by the Saxon builders. It was built of rubble to the string course, about half its present height, and roofed at the same pitch as the nave. It was without buttresses, and had two small windows in the centre of the north and south walls. The Normans strengthened the work by outside buttresses, by massive columns and arches inside, and then carried upwards their new superstructure of ashlar, working it in with the new outside buttresses. They intended to carry the work six feet higher than it is now. At the top there are the lower parts of four windows, intended to be finished off with round arches. But the mixed work below showed weakness, and the windows were built up level with the walling. The west wall of the tower contains a square-headed doorway, at the bottom of which a groove has been cut to admit the largest bell. There were four bells hung in the loft. In the north wall a Norman window has been inserted

subsequent to the addition of the buttress which occupies the central position. On the south side the S.W. buttress probably dates from the Sixteenth Century. There is a small round-headed window east of the central buttress, and in the Seventeenth Century a larger window with a brick arch was inserted, but is now covered with cement. The early windows had no glass, but were closed with wooden shutters.

The roof was of good English oak, covered with lead 3-16th inch thick. The earliest date scored on it is 1381.

The interior presents many features of interest and some curious problems. The floor of the nave runs down about four inches towards the chancel. Ten inches beneath the floor are three or four feet of human remains and sand. Between the choir and the chancel is a broad step raised some six inches above the level of the nave, and from this we again descend on going forward into the chancel. Both choir and chancel have four columns, one in each corner, which bear two groined arches, semi-circular stilted, and support stone vaultings. These arches are of Purbeck "Burr," a stone now obtainable only from rocks which appear at low tide thirty yards east of Swanage Quay. No other arches of this stone are known in the neighbourhood. The rough rubble work reaches a height of about four feet. The capital of the N.E. column bears the Consecration Cross.

In the choir the Norman arch has suffered much from settlement. It is believed to have been built inside a Saxon square-faced stilted arch. The earliest capitals are decorated with carved ferns and harebells. Two corbels seem to have supported a rood beam; three holes to fix the rood to the ashlar work are to be seen in the wall above. Over these are the remains of a fresco; there is a standing figure with one kneeling on either side. The nave arch is Norman, slightly stilted, with hatchet and basket mouldings on the capitals. The end beam of a side gallery was once inserted in the north capital.

The font stands at the west end of the Church. It is axed out of Purbeck "Burr," and may date from the Twelfth Century. It stands on a stone which was once a window head and was evidently taken from the N.E. nave window.

On the north side of the chancel there stands an altar tomb, and the suggestion is made in *The Architectural and Topographical Record* for June, 1908, that this was the original high altar of the Church, and that it stood on the step which now separates the chancel from the choir, so that the choir was originally the chancel and the present chancel was built to the east of it as a Lady Chapel. This would account for the step which is otherwise difficult to explain. It might also account for a hagioscope which has been cut so as to afford a view of a reliquary at the back of an altar placed on the step, but which could not possibly have been directed on the Host with any position of the altar. It is, however, difficult to believe that a Lady Chapel can have been built as early

as Saxon days, and the greater portion of the walls of the present chancel are of Saxon rubble. The problem is interesting and deserves the attention of those who can speak as experts.

Brief Notes on the Plates
provided by the Photographic Section as Specimens
of the Work of the Session.

By E. DODSHON, LL.B.

PLATE III., NO. 2.

Bingham's Melcombe is probably the oldest house of its kind in the County of Dorset, having belonged for six centuries to the Bingham's who, with few intermissions, resided in it, without a break in the male succession, from about 1250 until the late Mr. R. Bosworth Smith acquired it. During the great Civil War it was the headquarters of the Parliamentary forces in the County of Dorset. The photograph shows the Courtyard and Gable.

PLATE IV., NOS. 1 & 2.

DOORWAY IN WEST SIDE OF TOWER, CORFE CASTLE CHURCH (No. 1).—A Tudor doorway under a square label, the spandrels filled on each side with tracery and a shield; the shield on the North is sculptured in a recumbent position. On each side of the doorway is a tabernacled niche supported by sculptured busts. The Church, with the exception of the Tower, was re-built in 1860. The other plate (No. 2) shows a child's stone coffin and stonework from the old Church.

PLATE IV., NO. 3.

Purbeck Marble Font, Kinson Church, Dorset.

PLATE IV., NO. 4.

THE FONT AT TONER'S PUDDLE (PYDEL OR PIDDLE) DORSET.—This has been described as a fine Norman Font with interlacing arches and nail-head ornaments, the character of its work bearing a considerable resemblance to that of Bere Regis. The circumference of the Font is slightly asymmetrical. The little Church was anciently a Chapel of Ease to Bere Regis. The place takes its name from the ancient Lords of the Manor, the Toners. In 27, Edward I., the Lord of the Manor was Henry Tonere.

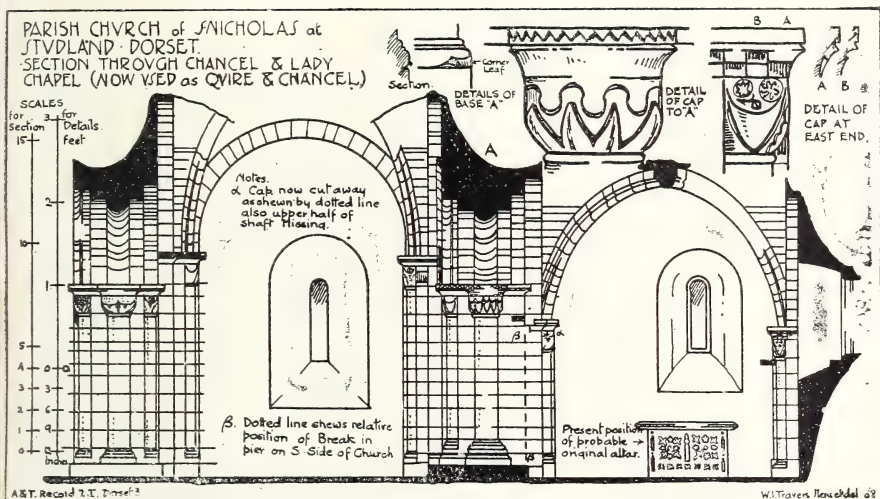
PLATE V., NO. 1.

BLOXWORTH HOUSE (BLOCA'S WEORTH) DORSET.—The Manor has been held by Richard Savage (and his descendants), Sir John Trenchard, and the Pickards (and the Pickard Cambridges), of whom Mrs. F. Lane, the present owner, is a direct descendant. The present Manor House dates, as to the front and greater part, from 1608, when it was built by George Savage.

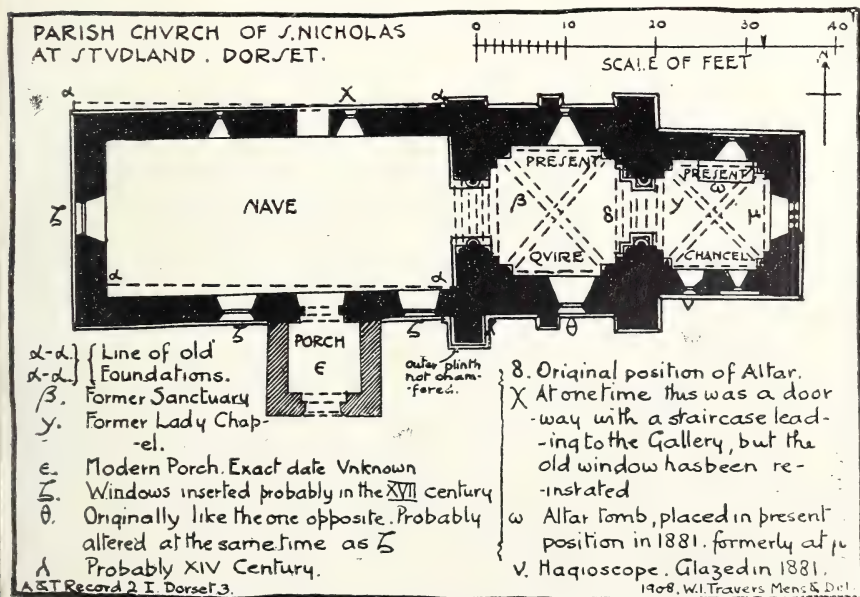
PLATE V., NO. 2.

WOODSFORD CASTLE.—The building stands near a ford on the River Frome some $3\frac{1}{2}$ miles below Dorchester, and was built in the reign of Edward III. The original roofing has been replaced by thatch. When this fortified dwelling-house was built it included four massive towers at the corners, and of these three have vanished. It will be observed that five doorways are included in this view of the South front. What is at present the principal doorway (the left in the illustration) was the entrance into the Chapel; a piscina and hagioscope still form part of the building. Towards the right of the photograph the semi-circular stair turret with its original stone roof is shown.





I. Studland Church, Longitudinal Section looking North.



II. Plan of Studland Church.

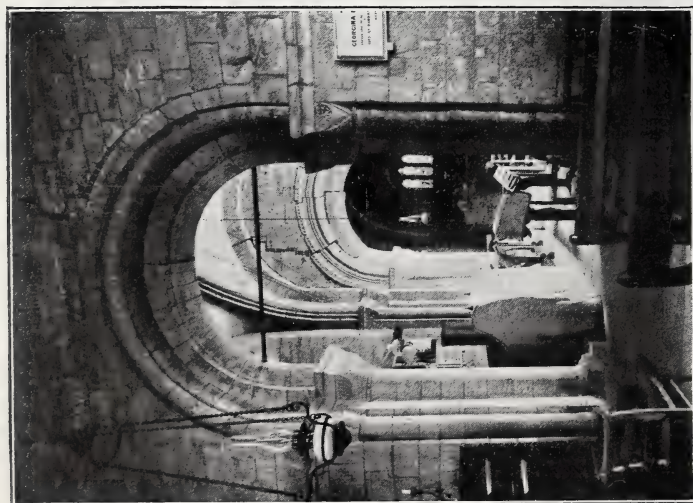


Photo by G. Brumell.
I. Interior of Studland Church.

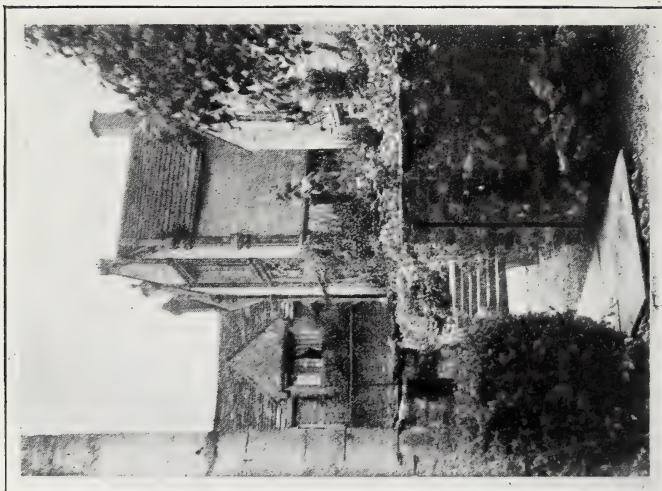


Photo by R. Y. Banks.
II. Melcombe Bingham, the Inner Court.



Photo by R. Y. Banks.

I. West Door, Corfe Castle Church.



Photo by R. Y. Banks.

II. Child's Coffin at Corfe Castle Church.



Photo by E. Dodshon.

III. Font at Kinson Church.



Photo by E. Dodshon.

IV. Font at Toner's Puddle Church.



PLATE V.



Photo by E. Dodshon.

I. Bloxworth Manor, General View.



Photo by E. Dodshon.

II. Woodsford Castle, South-West View.

CARBON.

A series of Papers dealing with Carbon and its Compounds in their
Chemical, Botanical, Geographical, Geological, and Utilitarian
aspects.

I.

An Outline of the Chemistry of the Element and a few of its Compounds.

BY HUBERT PAINTER, B.Sc., F.C.S.

(Read before the Physical Section, January 15th, 1916.)

THE lecture I have to give this afternoon is intended to be the first of a series dealing with Carbon. I have, as far as is possible in a single hour, to give such an account of the Chemistry of Carbon as may form a useful introduction to the lectures that are to follow. The subject is large, the time is short, let me begin by trying to answer the question: "What is Carbon?" Briefly, Carbon is one of the chemical elements; moreover, it is that one which is most characteristic of animal and vegetable substances. Protoplasm has been declared to be the material basis of life; we may add to this dictum that Carbon is the material basis of protoplasm. No sooner is a question answered than another, or several others, arise out of the answer. Thus it may be asked: "What is a chemical element?" To this I should reply: Whatever views metaphysicians may hold concerning the ultimate nature of matter, the chemist, for the purpose of his science and within its limits, has to recognise matters rather than matter—i.e., he finds there to be a relatively small number (something under a hundred) of different kinds of matter. These are, so far as we are at present advised, simple and inconvertible one into another. Every material thing with which we are acquainted consists of these elements, of a single one, or of two or more united in that specially intimate way known as chemical combination; or, thirdly, and most frequently, of compounds mixed together. Carbon occurs in nature in all these three ways. It is sometimes found isolated, or, as we say, in the free state; again, pure specimens of compounds of Carbon are sometimes met with, and, lastly, complex mixtures occur containing two or a larger number of carbon compounds associated, it may be, with yet other compounds containing no carbon. In what follows I shall not confine myself to substances existing ready-made in nature, but shall

also speak of some that have undergone a greater or less amount of artificial treatment either to produce them or to obtain them separated from other substances with which, in nature, they may be mixed up.

There are at least three varieties or, as we say, allotropic modifications of carbon existing as a free substance. These are known as diamond, graphite and amorphous carbon. Of the last charcoal is a familiar example. The diamond, on account of its extreme hardness and brilliant lustre, has been valued for many ages, and these properties, together with its rarity, placed it in, or near, the front rank of gems long before anything was known of its chemical nature. It was, indeed, thought to be a special variety of rock crystal—*i.e.*, of what we should now call crystallised silica. Sir Isaac Newton appears to have been the first to suspect that it was of an altogether different nature. The great lustre of the diamond is due to its great power of bending or refracting light. Newton compared it with turpentine, camphor, amber and other combustible substances and found that it exceeded these in refractive power in much the same proportion that it exceeded them in density and concluded that it was a fatty or unctuous substance congealed. Later on numerous experiments were performed to ascertain the behaviour of diamond when strongly heated. It was found that a diamond completely disappeared when placed in the focus of a powerful burning glass and, later still, it was shown that it undergoes a true combustion when powerfully heated in air or oxygen and that the product of its combustion is identical with that of charcoal. Thus the chemical identity of two substances, apparently so unlike each other, was established. The proof was made quite complete by quantitative experiments towards the end of the 18th Century. By these it was shown that when equal weights of diamond, graphite and charcoal are separately burned in oxygen equal weights of carbonic acid gas are produced in all three cases. Diamond is the hardest of all natural substances; it scratches every other substance and is itself not scratched by any. It is a poor conductor of heat and electricity, and has a specific gravity of about $3\frac{1}{2}$. Thus, if a piece of rock crystal were cut to resemble a diamond it might be distinguished from it, not only by its inferior hardness but by its less weight. If both were the same size and if the diamond weighed 35 grains the rock crystal would only weigh 25 grains. Fresh eggs may be distinguished from stale ones by preparing a strong solution of salt in which a fresh egg will just sink, whereas a stale one will float. In like manner a very heavy solution may be made in which a true diamond will just sink, but an imitation one will float. The natural occurrence of the diamond I leave to the geological lecturer, but it will be fitting to add a word as to its artificial production. This was first effected in 1893 by the French chemist, Henri Moissan. His method consisted in impregnating iron with charcoal by heating them together in the electric furnace and then very suddenly cool-

ing the molten iron containing the carbon dissolved in it. The mass was subjected to the action of acids which dissolved away the iron and a few minute diamond crystals were found in the insoluble residue. These were mostly of microscopic size but answered every test for diamond and were as truly real diamonds as any that were found in nature. Although the experiments have been repeated with various modifications by several chemists it has not yet been found possible to make diamonds big enough to be of any commercial value.

Graphite is another form of crystallised carbon. It differs from diamond in many ways. It is soft instead of hard, black and opaque instead of colourless and transparent, much less dense (specific gravity about 2.15th), and a fairly good conductor of heat and electricity. It occurs in nature and can also be prepared artificially. It was formerly supposed to be a compound or a peculiar variety of lead, hence the names black-lead and plumbago by which it is still often known.

Amorphous carbon can be obtained in many ways and it is not known for certain whether there are more than one and, if so, how many, chemically distinct modifications of this substance. Its physical properties certainly differ considerably according to the source and method of production.

When wood is heated so that air is excluded a number of gases and vapours are evolved and a residue remains, black, infusible, and insoluble, known as wood charcoal. An account of the many uses of this and of the way in which it is prepared will be given in a subsequent lecture, but I may mention here its power of absorbing or occluding gases. As a general rule the gases that are easily liquefied are absorbed to a larger extent than those which are difficult to liquefy and the absorbent power of the charcoal is different according to its source. For example, that made from cocoa-nut shell is specially active in this respect. Charcoal, or a similar form of amorphous carbon, may be obtained by the action of concentrated sulphuric acid upon various organic substances, the most suitable of these being sugar. By heating animal matter such as flesh, dried blood, or bones, animal charcoal is produced. As in the case of wood charcoal, air must be excluded during the heating process or the charcoal would itself be burnt. This kind of charcoal is particularly useful for the absorption of colouring matters.

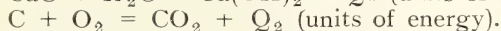
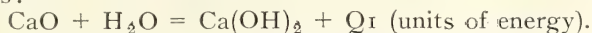
I have already said that diamond, graphite and charcoal, when burnt in oxygen, give the same product, namely, carbonic acid gas, and that equal weights of this gas, and no other substance whatever, are produced when equal weights of the three forms of carbon are burnt. It is also possible to convert diamond into graphite by powerful heat in the absence of air, and the conversion of charcoal into diamond, as in Moissan's experiments, completes the series of transformations. Thus it is beyond doubt that the three substances are, at bottom, identical in nature.

The existence of a single element in two or more allotropic

forms is so familiar to those who are much employed in the study or practice of chemistry that the marvel and mystery of it cease to be properly appreciated. There are, I think, two principal ways in which our curiosity is appeased and our feelings of wonder in the presence of natural marvels made to subside. First, there is the legitimate way. An explanation is found for that which at first seemed inexplicable. The curiosity and wonder originally excited are allayed but usually they break out again in connection with some other and profounder problem that comes into view when the first one has been solved. Secondly, there is the illegitimate way. In this case no solution is found, but mere familiarity blunts the edge of our curiosity and we cease to wonder at what used to excite our astonishment. Philosophy and science, in so far as it is philosophical, seek to discover the One in the Many and the Unchanging behind the perpetual flux of phenomena. To the chemist, it is the Atom that remains unchanged. The properties of bodies which impress themselves upon us through our senses, belong, not to the atoms as such, but to molecules, which are special collections of atoms, and to larger aggregates built up of molecules. We cannot say, for example, that the atoms of carbon are either black or white; blackness and opacity belong to the molecules of graphite, but are absent from the diamond, whose molecules are, doubtless, built up of different numbers of atoms differently arranged, although the atoms themselves are the same in each case. The differences between the three forms of the free element carbon may be compared with those between a church, a railway station, and a dwelling-house; all built of the same kind of bricks and yet profoundly unlike. The difference between molecules built up of the same kinds of atoms is, in fact, an architectural difference.

I must now leave the subject of uncombined carbon and pass to the chemistry of a few of its more important compounds, beginning with those it forms with oxygen. Three of these are known, the three differing from each other, not only in properties, but also in the ratio of carbon to oxygen. The most important is carbonic acid gas or, in more modern nomenclature, carbon dioxide, almost affectionately known to chemists as CO_2 . Here one atom of carbon is united to two of oxygen and, as the atomic weights of carbon and oxygen are to each other as 12 is to 16, the proportions by weight are 12 of carbon to 32 of oxygen, or, yet again, 3-11ths of carbon and 8-11ths of oxygen. This gas is formed, as has already been stated, when any one of the varieties of carbon is burnt in oxygen or in air. It equally results when any substance whatsoever containing carbon is completely burnt. All our ordinary fuels do contain carbon; peat, wood, charcoal, coal, coke, mineral vegetable and animal oils and fats, alcohol and so on, these all yield carbon dioxide when burnt. Most of these contain hydrogen also, and so the combustion gives rise to water vapour as well, but with this we are not at present concerned.

There are two aspects of a chemical reaction such as the combination of carbon and oxygen now under consideration. One is the material aspect, the other the energetic aspect. From the point of view of human convenience sometimes the one, sometimes the other, is the more important. Consider these two equations:—



The first refers to the action of water on quick-lime. Slaked lime is the material product, heat is evolved. When the builder slakes lime he does so because he wants the material product, the slaked lime, to use in making mortar. The evolution of heat is to him of quite secondary importance. It may assure him that his lime is of good quality, but otherwise is of little interest to him.

The second equation refers to the burning of carbon. Carbon dioxide is formed; this is the material product, but energy, chiefly in the form of heat, is simultaneously set free. When the Frenchman burns charcoal in a brazier or we burn coal or coke, it is done, not usually for the sake of the material product, but for the immaterial one, the heat that is evolved. In burning candles, our object is not to produce carbon dioxide and water, but to get the benefit of another form of energy, namely, light. The combustion of carbon, or of carbon-containing substances, is our principal means of obtaining not only heat, but useful electrical and mechanical energy. Thus it is the energetic rather than the material aspect of our second equation which is of the greater practical importance to us.

There are many other ways in which carbon dioxide is produced, among these may be mentioned—

1. It is formed in the respiration of animals.
2. Processes analogous to animal respiration occur in the case of plants. During the germination of seeds, for instance, there is an elevation of temperature and a formation of carbon dioxide.
3. During fermentation large amounts are set free.
4. The action of heat on carbonate of lime and most other carbonates, that of sodium being one of the exceptions, liberates the gas.
5. By acting on carbonates with acids carbon dioxide is readily and conveniently produced.

Kipp's apparatus, when charged with marble and diluted hydrochloric acid, is very suitable for preparing the gas for experimental purposes. With such an apparatus we can easily show some of the chief properties of the compound such as its density, about $1\frac{1}{2}$ times that of air; its action in extinguishing flame, precipitating lime-water and reddening blue litmus.

Carbon dioxide exists in the air to the extent of 35 or 40 volumes in 100,000. In the narrow streets of large towns and

still more in badly ventilated rooms where gas is being burnt and many people are collected the proportion is considerably higher. The quantity is small relatively, but absolutely it is very large. The late Sir Henry Roscoe calculated that the total amount of carbon dioxide in the earth's atmosphere exceeds three billion tons (3×10^{12}), which, he says, is probably more than would be formed by the combustion of all the animal and vegetable matters now existing on the earth's surface. The waters of the ocean also contain large quantities of carbonic acid, and interchange between the air and water doubtless contributes to the maintenance of the relatively constant proportion of the gas in the atmosphere in spite of the many causes that tend to produce variation in this proportion. By combustion, by the respiration of animals, by fermentation processes and by the slow decay of organic substances carbon, in the form of its dioxide, is constantly passing into the air. Green vegetables, on the other hand, in the presence and through the agency of sunlight, are as constantly removing carbon from the air. In this process solar energy is absorbed. This building, for example, is warmed by hot water. The water is heated by furnaces in which coal, raw or previously coked, is burnt. The coal is derived from the residue of ancient vegetation buried during long ages in darkness and silence beneath the earth's surface. As it burns the energy derived from the sun many ages ago is restored, and we benefit by its outpouring. Carbon monoxide contains, to a given weight of carbon, just half as much oxygen as the dioxide. It is a lighter gas than the latter, almost insoluble in water, very poisonous and burns with a blue flame. This very characteristic flame is often seen in our domestic fires when the grate is full of a glowing mass of coal. It is formed in this and other cases when air or carbon dioxide comes into contact with heated carbon or carbonaceous matter and can be prepared in a number of other ways. It is an important constituent of water-gas, formed by the action of steam on white-hot coke and used as a substitute for, or mixed with, ordinary coal gas. Its reducing property, i.e., its aptitude for removing oxygen from compounds containing it, render it valuable in metallurgical operations.

The third oxide of carbon (C_3O_2) was discovered comparatively recently. Carbon suboxide is a gas of pungent odour condensible to a liquid boiling at $70^\circ C$. It is obtained by distilling malonic acid $CH_2(COOH)_2$ under reduced pressure, with ten times its weight of phosphorus pentoxide.

The hydrocarbons are the compounds of carbon and hydrogen. These are exceedingly numerous, some hundreds being known. The simplest of all is methane or marsh gas (CH_4). It is evolved during the decay of vegetable matter, hence its name. It is present in coal gas and sometimes escapes from coal spontaneously, being, in fact, the dreaded fire-damp of the coal mine. No other hydrocarbon contains so large a proportion of hydrogen as does methane.

There are several other gaseous hydrocarbons, e.g., olefine

and acetylene, still more are volatile liquids, a mixture of these being the petrol of the motorist, others again are oily, others jelly-like, yet others hard and waxy. On the chemical side they may be grouped into series each containing many members having a general resemblance in the internal structure of their molecules and their chemical behaviour. As examples of such series may be mentioned the paraffin, olefine, benzene, naphthalene and anthracene series. Many hydrocarbons occur in nature ready formed in mineral oils and waxes and in the volatile oils of plants, others are obtained by destructive distillation of coal and other organic substances, yet others have been built up by synthetic methods. The number of hydrocarbons is very great, but that of compounds derived from or connected with them is far greater, but, important and interesting as is the subject, I cannot now pursue it farther. Of many classes of carbon compounds I must omit even a bare mention, but I will just give the names of two or three such classes. The metallic carbides are the compounds of carbon and metals, those of calcium, aluminium and iron being of special interest.

Carbohydrates contain carbon, hydrogen and oxygen, the two latter elements in the same proportions as in water. This class include the starches, dextrins and sugars. Compounds of still greater complexity, containing nitrogen as well as the three elements just mentioned, are characteristic of all living organisms whether animal or vegetable. In this planet, at least, carbon compounds are the indispensable vehicle for the manifestation of life.

My time is now exhausted. I aimed, in this lecture, at giving such an account of the chemistry and physics of carbon and its compounds as should help those who have not studied chemistry or have forgotten what they once knew to follow intelligently the remaining lectures of the series. I could not expect completely to attain my aim, but I hope that I have not altogether missed it.

Note.—This lecture was illustrated by a number of experiments.

II.

The Uses of Carbon in Plants.

By REV. PROFESSOR G. HENSLOW, M.A., F.L.S., ETC.

(Read before the Botanical Section, February 24th, 1916.)

CARBON (C), in combination with the elements of water (H_2O), forms the entire structure or framework of plants chiefly as a substance called Cellulose ($C_6H_{10}O_5$) and its various modifications according to the locality in the plant.

In the mineral condition carbon is only pure in the diamond;

next comes plumbago, commonly called "Black Lead," which contains one p.c. of impurity, while anthracite and common coals leave considerable amounts of ash when burnt. Jet is regarded as fossilized wood, while peat is the starting point of change from living vegetation.

Not one of these, however, supplies vegetables with their carbon as all are solids, and roots can take up no minerals unless they be in solution with water. The carbon of plants is solely derived from the carbonic acid gas of the atmosphere, which is absorbed by all their green parts. The air is composed of four-fifths Nitrogen (N_2), one-fifth Oxygen (O_2) and four ten-thousandths Carbonic Acid Gas (CO_2). This is derived from all kinds of combustion of organic substances or by breathing, for both animals and plants respire in the same way. Much is also given off from volcanoes as many minerals are "carbonates," i.e., combined with carbonic acid gas, as all chalk and limestone, as well as certain ores of iron and other metals. To understand how carbonic acid is taken in by the leaves, we must examine their structure. A leaf-blade is covered by the skin or epidermis composed of flat cells united together so that it can often be easily peeled off. Below the upper epidermis are elongated cells, upon the upper ends of which the skin rests. This is called from their appearance the "palisade" layer. The lower half of the leaf has roundish cells more loosely cohering. The cells of both these layers abound with green balls of living substance called protoplasm. They are named "Chlorophyll," i.e., "leaf-green." The chlorophyll cannot absorb CO_2 in the dark, nor can it be formed itself without light, as it is certain rays of the solar spectrum, such as nature displays in the rainbow, which are chiefly concerned in the absorption and decomposition of CO_2 .

A spectrum can be made by a three-sided prism of glass, by which the normally colourless light is split up into red, orange, yellow, green, blue, indigo and violet, which we can see, but other rays are invisible, such as heat-rays beyond the red at one end and ultra-violet at the other. By growing plants, such as lettuces, under coloured glasses it will be found that they grow very differently; the height is greatest under red, and is shorter and shorter as we pass from red to blue, and shortest of all when grown in the open ground. They will all be green, but when they are dried and weighed then we can ascertain the different amounts of solid carbonaceous matter in each. The maxima are always under the yellow and the blue glasses; smaller amounts occur under red and violet glasses.*

When the coloured glasses were examined with the spectroscope it was found that they were rarely pure, the red and the green being the best. Now the red is found brightest at the extreme end, but continued fainter up to the usual position of the green. On the other hand, with the green glass, the colour spreads

* I could not get a good "indigo" glass.

as far as the usual beginning of red. In other words, what we call orange and yellow are not pure colours at all; the former may be represented as 2 R. + 1 G. and the latter as 1 R. + 2 G., the three primary colours being really red, green and blue, all others are the results of combinations.†

There is a curious feature in the spectrum of the sun to be considered. The solar spectrum is found to be full of black lines across it. When first discovered, no explanation could be given; but when the spectrum of the monochromatic light of sodium (as when salt was put in burning spirit in the old days of "snapdragons" at Christmas) is examined a pure yellow light without any other colour is seen. On comparing this with the solar spectrum, where the latter showed a black line only, the spectrum of sodium showed a yellow one only, *in exactly the same place*. This was the first coincidence. When by vaporising other substances, many other coincidences were discovered, as of iron, so many had been exactly "matched" that it was felt we were justified in saying the lines represented the same substances in luminous vapours round the sun. The black lines mean that in passing through the vaporous coverings of the sun some portions of light get absorbed and do not reach the earth. Some may also be absorbed by our atmosphere. Now let us turn to chlorophyll. By pouring spirits of wine upon some macerated leaves and straining it, a green solution of chlorophyll can be obtained, and, looking at this, held up to the light, through the spectroscope, we find seven black bands; indicating the fact that the sun-light is partly *absorbed by the chlorophyll*. We infer, therefore, that the *two* in the orange and *two* in the blue are the chief elements of sun-light required in the process of assimilation of carbon out of the CO_2 from the air.

What is the result? Omitting primary effects of the mysterious process effected by light, the first *visible* product is starch-grains arising on the surface of the chlorophyll granules. These increase in size till little of the chlorophyll-granule to which they are due can be seen. The starch grains of different plants vary in size and other details, so that they easily betray their origin. Thus potato-starch is very large with concentric rings, rice starch is very small, arrowroot has rays marked out, etc. Hence adulterations of arrowroot can easily be detected with the microscope. Having seized the carbon out of CO_2 , the oxygen is dismissed and sent back into the air; thereby purifying it again, for CO_2 is an impurity, even on the increase from the above mentioned sources.

Having thus started with the manufacture of starch, nothing can be done with it until it can be dissolved, so that Life directs the forces involved in working out chemical changes in all organic products and converts starch into sugar. Starch being $\text{C}_6 \text{H}_{10} \text{O}_5$,

† Prussian blue with gamboge makes green, because the green overpowers, and 1 Blue + 1 Red + 2 Green = Green (to the eye).

by combining more molecules of water (H_2O) it becomes $\text{C}_6\text{H}_{12}\text{O}_6$ grape sugar and fruit sugar, or else $\text{C}_{12}\text{H}_{22}\text{O}_{11}$ (cane sugar). In this state it is transmissible and conveyed to all growing parts, where it is the material for making cellulose, which has the same constitution as starch ($\text{C}_6\text{H}_{10}\text{O}_5$). Indeed, several other substances are of precisely the same proportions, such as gum, dextrin, mucilage, etc. As they all have the same substances, carbon and water, they are called carbohydrates. Many other carbonaceous products occur in plants, but the elements are in different proportions; thus, the outer portion of the cell-wall of the epidermis is called the cuticle. This has the following proportions:—C, 73.66, H, 11.37, and O, 14.97. There is another in cork, C, 74, H, 10, O, 16. Then there are several kinds of oil as in nuts and olives, with similar high proportions of carbon, hydrogen, and oxygen. These all have their uses in plant life; thus, while starch is the commonest food for the embryo to germinate upon, as in wheat, in kernels of nuts and almonds it is oil.

The only living substance, protoplasm, has been alluded to. This carries the life of the plant. It is found in all growing and living cells. Its composition consists of carbon, hydrogen, nitrogen, oxygen, sulphur, and phosphorus; but these elements are in such high proportions that it has never been accurately analysed. One of the nearest approaches to it is albumen forming the white of an egg; and as several nitrogenous products of plant-life approximate to this they are called albuminoids. These are the substances which renew the protoplasm and supply food for the new cells as they are continually being increased in number. Like starch and oil, as well as other things without nitrogen, albuminoids are stored up as reserve food for future use. Starch is the chief thing in potatoes, which give rise to new plants; while sugar is found in turnips, beetroot, carrots, etc., for the second year's flowering process; whereas, both starch and albuminoids are found in considerable quantities in seeds for the germ or embryo to live upon until it has developed roots and leaves.

Similarly as the animal kingdom lives upon the vegetable, these same substances constitute its food also, for the analysis of animal and vegetable protoplasm is practically the same.

As an example let us take a grain of wheat. This is a seed invested by the carpel as forming an extra coat. As this consists of three layers of cells, while the seed itself has two, the wheat-husk consists of five. Excepting two layers, they are useless (that is, as food for the embryo), but the late Sir A. H. Church discovered that they contain certain salts which are beneficially added to the food proper.

The outermost layer of the internal food-substance, called the endosperm by botanists, and forming flour when ground, consists of cells filled with the reserve albuminoids. It is called the "cerealín" layer, and is the part which is of the greatest importance. For all the rest, excepting the germ or embryo,

consists of cells with starch and but little else, the germ being at the base of the seed where a wrinkled spot may be observed externally. This germ, though very small, is highly nutritious, but it is usually discarded by millers, as it is apt to impart a colour which detracts from the whiteness of the flour. This whiteness, however, indicates its defect in nutrition, for it is due to starch which contains no nitrogen.

If the bran—which includes the cereal layer—be removed, this valuable layer is lost. Consequently, to secure the full value of the wheat the entire grain should be ground up, such being best of all, *provided* it be sufficiently *finely ground* and very carefully sifted to remove all extraneous matters as pieces of chaff, scale, etc., often to be found in coarsely ground whole meal.

The following are a few samples of the carbonaceous products of vegetables having the same ingredients, namely, carbon, hydrogen and oxygen, the carbo-hydrates being $C_6H_{10}O_5$; cellulose, starch, inulin (in Jerusalem artichokes), lichenin, gum, dextrin, levulin, mucilage. These are all carbo-hydrates. Of sugars, there are saccharose, i.e., cane sugar $C_{12}H_{22}O_{11}$, laevulose (fruit sugar) $C_6H_{12}O_6$ and glucose (grape sugar), also $C_6H_{12}O_6$.

Of wax and oil, are stearin, palmitin and olein. These have the three elements in largest proportions, thus olein is $C_3H_5(C_{18}H_{33}O_2)_3$ or, in percentages, C, 77.4; H, 11.8; O, 10.8. There are numerous acids all composed of carbon, hydrogen, and oxygen, but in varying proportions. Such are formic, acetic, palmitic, stearic, oleic, lactic, oxalic, malic, tartaric, etc.

Besides this long list, there are several other things composed of carbon, hydrogen, and oxygen.

Nitrogenous products. These are composed of the same three elements together with nitrogen. Asparagine, in the asparagus, is an example, and they are summed up as “albuminoids,” forming the most important substances of food.

Alkaloids form an important nitrogenous group, many being useful to us, others are poisonous. For example, tea, coffee, Paraguay tea, and cocoa. Though of quite different families, all contain the same, which gives the peculiarity to these drinks. Of poisonous alkaloids, there are conine of hemlock, nicotine of tobacco, morphine of poppy, strychnine, atropine of belladonna, etc.

These are all made by the action of Life by inducing chemical changes among the elements of plant food, all having doubtless some useful purpose in the plant, but it cannot be traced in every case.

Let us briefly consider what combinations of these products are best able to build up and restore waste in animal life; what may be called the most nutritious diet or the typical food. This should consist of the three ingredients, farinaceous (starch), oleaginous (oil or fat), and albuminoids or nitrogenous (proteids). Nature seems to have suggested the following associations, without our cooks knowing the reason why—bread, butter and cheese;

potato, bacon and beans; bread, bacon and eggs. It was customary in former days always to put little cubes of bacon in pea-soup; for peas, beans, lentils and other members of the same "leguminous" family are very highly nitrogenous, containing about 22 per cent. of albuminoids, while potatoes contain about 2 per cent.; on the other hand the peas have 51 per cent. of starch. It may be added that too great a deficiency in any one of the three is injurious. It is said that "beri-beri" is caused by too great a rice-diet, this grain being very deficient in nitrogenous substances, 7.5 per cent., starch being 76; while wheat has 11 of albuminoids and 69 per cent. of starch. We have now had a general survey of carbon as widely present in plants, but always in combination with other elements. It only becomes visible as a mineral when turned to charcoal or soot.

We must now consider how the *energy* is supplied to *Life* wherewith all these compounds are made, just as we cannot use an engine unless coal is burnt or some other source of force can be utilised, as a waterfall, from which the force of gravity is extracted.

The process of respiration is the same, but in a much milder form, as burning. In a candle the carbon of the wax or tallow is "burnt," i.e., when heated it unites with the oxygen of the air and thus forms carbonic acid gas, which is so hot as to be coloured red or yellow and makes the flame, while water is given off at the same time. This is easily shown by putting a cold, dry metal spoon just over the tip of the flame, when dew appears and momentarily rests on the outer surface of the bowl of the spoon.

To supply energy in plants, a carbo-hydrate is usually taken and decomposed by the plant, with the aid of oxygen from the air, into carbonic acid gas and water, while the energy, originally absorbed from the sun's rays in the formation of the carbo-hydrate, is liberated and is at the disposal of Life wherewith to carry on all its vital functions. The chief stimulus to respiration is heat, or the obscure rays beyond the red in the solar spectrum.

By plotting out in a curve the increase of CO_2 by respiration with the corresponding degrees of heat applied, it is found that the curve becomes a parabola, that is, the same curve as a stone will take if thrown up into the air. It is a continuous curve, so that it seems to show that the only limit would be death to the plant if the heat be too strong, as practical experience tells us is the case.

Burning and respiration are thus seen to be practically the same thing; the effect in both animal and vegetable kingdoms is the same—the liberation of energy for life-work.

Now let us turn to the use to which plants put their cells. At first, as in herbs, there is much soft cellular tissue usually charged with water for the plant's use; while in some tropical and other countries, with situations of great drought in which plants have to tide over rainless periods, cellular tissue is converted into water-storage reservoirs. Thus the curious massive forms of

cactuses and the prickly pear are so constructed as to be great water-storage structures, the "pseudo-bulbs" or swollen internodes of tropical epiphytic orchids are veritable water-bottles with an extraordinary strong skin to prevent evaporation. With timber the cells take on a spindle shape so that they can be compacted together and resist transverse breakage; while the cell-wall becomes lignified with a modification of cellulose called "lignin." Hence arises the great strength of wood to resist gravity and bear a tree upright. One layer on the outer-side of the wood, called the "cambium," remains in a state of active growth. This gives rise to a new cylinder of wood annually, so that the age of trees in this and most countries can be told by counting the cut ends of the cylinders, looking like rings of wood in a transverse section of a trunk of any timber tree. This, however, cannot be done in a palm tree, as no cylinders of wood occur; all the woody bundles, which collectively make a cylinder, are scattered about in the general mass of cellular tissue. The cause of this has been shown to be, without much, if any, doubt, an ancestral condition of living an aquatic life.

The principal parts played by carbon in vegetation have now been passed in review, from its origin in carbonic acid gas to its numerous final uses in the solid framework of all plants and every part of it, and secondly the numerous carbonaceous products, each and all having some special use in plant life though we cannot always discover what that use may be.

Lastly, we have seen that when a hydro-carbon is destroyed and resolved into carbonic acid and water, both being discharged into the air, the energy set free by the process enables the plant to carry out all its functions and repeat the same processes as long as it exists alive.

III.

Carbon from the Geographical Standpoint.

By W. J. WOODHOUSE, A.C.P.

(Read before the Geographical Section, March 25th, 1916.)

FOR the third time I have the pleasure of addressing to the Geographical Section a lecture on some chemical element and its relationship to geography. I have now to deal with carbon along these lines.

In my contributions on Silica and Calcium I dealt very largely with the scenic effects and landscape pictures which are characteristic of the presence of these elements, while the economical branch of geography received a secondary position. In carbon I am compelled to reverse this order, which will mean that the topographical will take a second place, whilst the economic will be of primary importance.

The geographical study of carbon is thus mainly an economic question and is probably the strongest link in the chain that binds man and his productive resources to our earth. Coal is a dominating factor, it practically controls all our terrestrial developments, and for this reason I feel compelled and justified in treating carbon from the economic standpoint. If any justification for this course is needed I suggest a view over our country in the throes of a prolonged coal strike. The most sceptical will be convinced of what amazing significance is derived from the coal box. All industries and manufactures go by the board. Our overseas commerce and communications are brought to a standstill and railroads are significantly hopeless. Coal is literally the life blood of our nation.

Coal and iron are such near relatives both in their distribution in the earth's crust and in their interdependence in commerce and manufactures that it is next to impossible entirely to separate them in their results and achievements. The iron industry is largely dependent upon that of coal. Iron was worked centuries before the use of coal, but in olden times the chief centres of the iron industries were in the forests or wealds. The Weald of Kent and Sussex, the Forest of Dean, and the Forest of Arden were the centres of the smelting and furnace work. Charcoal burning for purposes of smelting was a common occupation in the forest areas, and heaps of slag overgrown with grass and weeds now mark the sites of ancient industries. Locally many such pictures are to be found, while in not a few instances the old names still linger which remind one of their past importance.

The constant supply of wood for the purpose of smelting and working of iron has resulted in many of our early forests being literally wiped out and exterminated. With advancement in scientific methods of treatment, lime became a necessity in smelting since it was used as a flux and to produce "slag." Thus the ideal conditions for manufacturing prosperity led the iron industry into areas where these three minerals were in close proximity. This brought about a rearrangement of the country's population, and the great iron and coal centres became the hives of the population. Many of our English centres are in the happy possession of these three minerals within their borders. How was it that the enormous deposits of ore in the Cleveland and Furness districts were not worked until late, say later than Birmingham? The answer will be apparent by noting that they lay away from the coal, which consequently had to be carried to the district, as it was cheaper to carry coal to iron than iron to coal.

The far-reaching effects of coal on our industries cannot easily be conceived and the various by-products, all supplying infinite employment, demand instant recognition.

For hundreds of years coal was considered of little importance. The manufactures of those times were literally "manufactures." They were positively hand made. The introduction of machinery revolutionised the centres of industry. The woods

and rivers were forsaken, and the coalfields became the homes of the manufacturers. Changes of this description have been very marked and apparent, but our coal supply is not illimitable and one of the questions we must steadfastly face is possible exhaustion of the coal measures. It thus behoves us to take the greatest possible care of our coal supplies that succeeding generations may not suffer from our deliberate wastefulness. Electric power is in part a solution to the case. Central generating and supply stations with distributing stations economically worked have effected considerable saving and still promise further economy as the principle of linking up becomes facilitated.

Thus the introduction of steam and electricity not only closed the riverside and windmills, but it produced great movements amongst the industrial population. The coal-bearing lands became the great hives of industry and the rush to the coal pit has been more marked and lasting than the great rushes which have raged like fevers about a newly discovered gold or diamond field. Fortunately for England, coal and iron have been abundant and in close proximity, and with care will probably last many years to come. Had it not been so industries and manufactures could not have assumed the gigantic proportions they have. Fortunately, too, the limestone belt is nowhere far from the coal-measures, and these have contributed in no small degree to our sound financial position. We are for this reason "A nation of shopkeepers," and the intended derision is now our national pride. The coal districts are important not only on account of the coal they supply, but on account of the industries associated with the production of coal. As an example we have the textile industry, for before the introduction of coal and steam the machines of Hargreaves, Arkwright, and Crompton were driven mainly by water power. After the invention of steam, mills were erected in the coal fields and the factory system was thus inaugurated, so that a large proportion of the population was moved bodily from the South and East, to the Midlands and the North.

In spite of the fact that England is deficient in the precious stones and the noble metals, the deficiency is more than compensated for in our mining productiveness. England is the most productive mining country in the world.

There are five distinct reasons for this.

- (a) The abundant supplies of coal, iron, and limestone, often found together.
- (b) The coalfields are widely distributed over the country.
- (c) The coalfields are for the most part situated near excellent and natural harbours, or close to navigable waters of rivers and canals.
- (d) The nearness to the great commercial nations of Europe and the consequent and easy exchange.

- (e) The importation of natural ores of all kinds avoids re-shipment to the smelting centres as these are situated in the coalfields in the vicinity of excellent harbours.

It is thus that coal materially favours an increase in our manufacturing productiveness and at the same time facilitates and adds to our material raw imports.

It is thus that the three great coal producing countries of the world, Great Britain, United States and Germany are also the chief producers of iron and have the largest manufacturing and transport industries in the world. The principal coal producing areas of England:

I.—The Yorkshire, Derbyshire and Nottingham coalfield (annual output 60 million tons). It supplies the woollen manufactures of the West Riding, the iron works of Sheffield and the textiles of Nottingham. The surplus is sent to London or shipped from Goole.

II.—The Northumberland and Durham coalfield (annual output 52 million tons). The coal is largely used in the iron districts of the counties. The surplus is exported. The region is bisected by the Tyne, to which belong the seaports which first carried on a great trade in coal, and is in immediate proximity to Sunderland and various minor ports, whilst its southern end is near the iron deposits of Cleveland in North Riding.

III.—The South Wales coalfield (annual output $44\frac{1}{2}$ million tons). Coal from this area is in demand all over the world. Some is used in the district for smelting iron and copper ores. Anthracite is shipped to all the great naval centres. Much is used in locomotive work on various lines.

IV.—The South Lancashire coalfield (annual output 29 million tons). It exports very little coal. Nearly all of it is used in the local cotton industry, engineering, and chemical works.

V.—The North Staffordshire coalfield (annual output 13 million tons). Nearly all the output is used in supplying power to the factories of the pottery district.

VI.—Other Coalfields (annual output 6 million tons).

- (a) **North Wales** supplies salt and chemical works of Cheshire.
- (b) **South Staffordshire** supplies fuel for the "Black country." Large quantities are sent to London by rail. It is badly situated for foreign and export trade, but admirably placed for home consumption.
- (c) **Cumberland** supplies smelting works at Furness, and the surplus is sent to Belfast for linen and distillery factories.

- (d) **Shropshire and Worcestershire** supply the potteries of the country and the woollen industry of Kidderminster.
- (e) **Forest of Dean** provides coal for local iron smelting and forging.
- (f) **Bristol** supplies the West of England manufacturing centres.

The presence of coal near the coast has led to specialisation in these fields of the industry of shipbuilding, whilst inland the demands for machinery of all kinds for textile manufactures have led to a specialisation in these centres in this direction. In Lancashire, Yorkshire, and Derbyshire machinery is urgently required for cotton and woollen industries. Further inland this import of raw material is not so easy, and the result is seen in the manufactures of the Staffordshire coalfield, where the special industry lies in articles whose chief value is in their workmanship, articles which demand a considerable amount of labour upon a small amount of raw material, e.g., screws, needles, pens, watch springs, etc. For a similar reason Birmingham and Coventry have specialised in bicycles, Sheffield in cutlery. The latter specialisation has been accentuated undoubtedly by the presence of millstone grit, which naturally suggests grindstones and grindery.

Coal has had its voice in the distribution of population in our great cities. The western portion is usually residential, whilst the eastern is comprised of factories and large smoky chimneys. When we consider that our prevailing wind is from the S.W. it is easy to see how this natural selection came about.

A very hard variety of coal which allows of its being cut and polished is responsible for another somewhat specialised and local occupation. Jet, which is found at Whitby, has given rise to the jet industry. In Aude, in France, it gives employment to numerous artisans, who work it into brooches, bangles, rosary beads, etc.

The scenic effects of the local measures is practically nil. Nevertheless peat offers a few which are unique to itself. The bogs are usually dark in colour and have become filled with sphagnum, hypnum, and other mosses, which give rise to peat. Though bogs are useless for agriculture, the peat obtained from them gives rise to an important industry. Besides being useful as a fuel, peat promises to become a source of "peat gas," a fuel and illuminant which gives good assurance for the future. It has been manufactured into blankets, carpets, wadding and paper. Gardeners use it also for the growing of heaths, rhododendrons, and azaleas, whilst peat briquettes are supplementing coal as a household commodity.

The type of fenland associated with peat is intersected with ditches, from which the peat is excavated to a depth of 30 feet. The pits are lined with stacks of peat blocks drying for the market. A unique fancy industry has sprung up in these areas. The roots

of fossilised trees much prized as a suitable substance for fancy furniture and knick-knacks have given rise to the industry connected with "bog oak." The districts of bogs are liable to slipping and to settlement, and occasionally the wet spongy ground on the slopes of the hills slides down bodily and destroys the fields and property below. Another feature of peaty scenery is the phenomenon known as "floating islands." There exist many in shallow lakes and sluggish rivers. They consist of masses of interlaced roots of plants, detached from the banks and float down the stream. Oftentimes they are compact enough to form soil, in which trees and plants grow, and on the Nile, Ganges, and other great rivers constitute what is known as "sudd." Perhaps the most singular and noted within our own borders is that at Derwentwater. They appear periodically to submerge and then emerge. The generation of gases produced in waterlogged vegetation apparently supplies the intermittent buoyancy and consequent fluctuations of level. In many parts of the world floating islands have been utilised for the production of such plants as cucumbers and melons.

The diamond is another natural form of carbon, and a few words must not be omitted from a geographical study. Although its importance is nothing like that of coal, in many minor ways the diamond has added its quota to the advancement of geographical discovery. New tracts of the globe have been opened up solely as the result of the discovery of the precious stone. Its rarity is responsible for its price and not its applicability to arts and crafts. Africa, particularly the Kimberley district, was almost entirely opened up as a result of diamond mining. Brazil has derived advantages for a similar reason. India, too, was very early noted for the precious stone, but owing to the ancient nature of the country and its tribes, coupled with their strife and contentions in conjunction with their extravagant use of the rarity the store of diamonds is now very small.

The principal source to-day is the Capt, but the control of the diggings is so carefully guarded that the output is not allowed to exceed the demand. This preserves the output of the diggings and maintains an almost uniform price. The diamond was responsible for at least one important commercial route. When boring the Cenai Tunnel rocks were encountered in the interior which were so hard as to defy the entry of a drill for blasting holes. The diamond drill was discovered to enable the work to proceed, and the job was finished. The diamond has been used throughout the world on similar occasions and on very similar aims.

Graphite, an allotropic form of carbon, is found naturally, and is the substance perhaps best known in the cosmopolitan article, the lead pencil. Its application in the arts and crafts are numerous, and hence it is in great demand, and in commerce is an important article. The great source of our own graphite was the famous mine at Borrowdale, in Cumberland, and pencil works

have originated in the locality at Keswick. These promise well since the importation of Bavarian and Austrian pencils is at present nil. Ceylon and the Straits Settlement, too, export large quantities. The blacklead of Siberia is almost wholly the monopoly of Faber, the pencil maker of Nuremberg.

Perhaps truly speaking another aspect of carbon would rightly fall to consideration from a geographical standpoint. Trees are largely carbon, and timber is an exceedingly important article of commerce. Conifers are largely used for building purposes. Firs and pines are mostly found in the colder regions of the world. Fancy and ornamental woods for furniture making are the products of the Tropics. Closely associated with timber is the manufacture of paper from wood pulp. Japan specialises in papier maché, another allied industry. Having barely mentioned the field now opened up, I must leave further consideration of such topics as cereals, sugars and starches, however important they may be commercially and domestically.

Pitch is a complex mixture of hydrocarbons. It exists in some few places in a natural condition, notably in Trinidad, from which place large quantities are derived. Other natural deposits are met with in Barbados, Venezuela, and Algeria.

Probably next to coal in importance is petroleum. It is to this that scientists have recently looked with longing eyes as a means of fuel when the coal shall become exhausted. Many engines have been devised to burn petroleum, and oil boats and oil engines are already transporting our commodities. The motor system of transport also depends upon petroleum, whilst the airship and aeroplane are both driven by its power. The general formation is much the same as coal. Organic remains by reason of internal heat become distilled with the production of oil, which becomes imprisoned in porous rock. Here it remains until "tapped" by a hole or boring. The most important oil fields in the world are in Transcaucasia, Pennsylvania, California, Mexico, Burmah, and even our own islands. Baku owes its existence to the presence of petroleum. Forests of derricks for boring and pumping are in the vicinity. A great "baler" raises 100 tons of oil per day. A "spouter" gusher often blows the derrick to matchwood and throws up anything from 7,000 to 10,000 tons of marketable oil, worth from £350,000 to £500,000, within 24 hours. The soil about is so logged with petroleum that inflammable gas escapes from the surface. Baku oil finds its way all over the world and gives Russia a cheap fuel for her steamers on the Caspian and Black Seas. With petroleum occurs oftentimes a natural fuel gas. In Pennsylvania the gas has been tapped, and is in such quantity that it has been successfully utilised for illuminating purposes in the city of Pittsburg and elsewhere. A petroleum boring at Heathfield, in Sussex, gave a steady supply and threw up a flame 16 feet in height. It has now been utilised for lighting the railway station.

Kimmeridge clay and shale, locally known as Kimmeridge coal, has recently yielded naphtha by distillation, and great promise is foreshadowed for a successful re-working of the seams. British paraffin and paraffin wax are distilled from bituminous shales around Edinburgh. Our staple fuel is perhaps coal, which yields a smoky and sullen atmosphere. It is interesting to compare the cleanliness of Paris in this respect, where coke and charcoal are largely used. The combustion of coal results in the production of compounds, which have a distinct disintegrating effect upon building stones, and concern is felt for many of our historic buildings in the Metropolis, whose walls are falling into decay owing to continued action of various compounds produced.

How long will our coal supply last? This has been a poignant and debatable question for long, but it would appear that owing to economy in consumption, to improvements in engineering, whereby electric power is being more largely used, and to the introduction of other fuels, that our coal consumption has about reached its maximum, and we may look for a decline in this direction. Although this is so, it must be borne in mind that the best varieties will be exhausted first, and, unlike other commodities, there is always a harvest, but only one seed time, and that was long ago.

IV.

Geology of Carbon.

By W. MUNN RANKIN, M.Sc., B.Sc.

(Read before the Geological Section, March 29th and April 12th, 1916).

CARBON occurs on the earth in a variety of compounds and in the free state. As carbon dioxide it is an essential constituent of the atmosphere and forms the source not only of the greater part of organic matter assimilated by plants of the present day, but also of the vast stores of carbonaceous material locked up as coal in sedimentary rocks. In combination with lime, magnesia, and other bases it forms a considerable part of stratified rocks, more especially of the limestones, chalks and marbles. Carbonates of iron, lead, and copper are amongst the chief ores of economic importance. The mineral sources of energy upon which modern industrial civilisation largely depends are essentially compounds of carbon with hydrogen. In addition to the coal already mentioned are petroleum, oil-shales, bogheads and torbanites. An almost pure form of carbon widely, though not considerably, distributed is graphite; and that wonder amongst minerals and chief of gems, the diamond, is also a form of pure carbon.

The geology of carbon is too vast a subject to be adequately treated except in an encyclopædic monograph, and all that will be now attempted is a short sketch of the various theories held on

the subject of the origins of the various forms in which the element is found in the earth's crust. We shall consider these in the following order: the origin of coal, that of petroleum, that of graphite, and that of the diamond.

The Origin of Coal.

Coals may be conveniently divided according to the supposed mode of deposition of the mother substance according to the following scheme:—

Terrestrial.

- Peat (in part).
- Lignites (in part).
- Brown coal (in part).

Lacustrine.

- Sapropelic coals (Cannel, Boghead and Torbanite).

Lacustrine and Estuarine.

- Peat.
- Lignite.
- Brown coals.
- Humic or "Bituminous" coal.

Of Uncertain Origin.

- Anthracite.

Peat is a substance of recent accumulation, and in general presents little or no difficulty on the question of origin. It is further interesting because of the light its distribution and accumulation throws upon the problem of the origin of some at least of the older coals.

Peat deposits occur on broad badly drained areas in the temperate zones, at moderately high levels as on the Pennine moors and at sea level on waterlogged coastal plains, as in the Fen and Broad districts of East Anglia, in Ireland and on the North German Plain. Three sharply defined types of peat are recognised: (1) the Fen or Swamp peat, which is accumulated by fen or swamp plants whose roots are bathed by the soil water of rivers or springs and are therefore supplied with a sufficiency of mineral salts; (2) the Moor peat, which is formed of the remains of plants that are dependent for their water supply upon the almost pure water of the atmosphere; and (3) the Transition peat, chiefly of wood and grass remains of the vegetation in transition from the fen to the moor. Fen peat is varied in composition, burns with a bright flame and leaves a fair proportion of ash. Moor peat consists largely of bog-moss, cotton grass, ling and similar heath moor plants. Its flame in burning is hot and a smaller proportion of ash is left. Peat is formed as the result of a process, called for lack of a better term "peatification"; as distinct from humification as it is from decay, though in what the process consists is practically unknown. An abundance of water, a lack of air, and a comparative rarity of bacteria appear however to be factors.

Lignites are conveniently considered as Lignites proper, con-

taining a high proportion of quite evident woody substances, and brown coal where woody structure is not obvious. Small seams of lignite occur in the freshwater and marine beds of the local developments of the Bagshot and Bracklesham Series. Considerable masses were accumulated at Bovey Tracey on the borders of Dartmoor in Oligocene times. Brown coals are widely distributed on the Continent in Tertiary deposits and have been much exploited within recent years in Germany, where they are almost as extensive as ordinary black coals.

Sapropelic coals comprise an interesting type. The Cannel coals, Bogheads and Torbanites differ from ordinary humic coals not so much in appearance as in the high proportion of volatile hydrocarbons they yield on distillation. Scottish boghead gave off 15,000 feet of hydrocarbon gases and 60 to 70 gallons of oil per ton, and left a considerable amount of ash. The evidence bearing upon the question of the origin of coals of this type so far as it goes indicates that they accumulated under water, either of lakes or quiet seas some little distance from the shores, as fine silt of well macerated plant structures mixed with material derived from molluscs, fish, etc., that inhabited the waters as well as with varying proportions of clayey mud. At the present time richly gaseous peat-mud accumulates in this way on the floor of tarns and lakes. This group of coals, it is suggested, belongs essentially to the same group of sediments as the oil-shales.

Humic or Bituminous coals comprise the ordinary household and steam coals of this country. The mother substance of this group is undoubtedly organic and vegetable. In some uncommon coals the structure of the composing vegetable material is still plain, but more usually the only indications of vegetable origin are either imprints upon the surface of associated seams of shale or petrification in calcareous nodules scattered rarely in abundance throughout the coal. Two theories of the origin of coal have been long opposed: the "Growth in situ" theory and the "Drift" theory the one holding that the mother substance accumulated where it now is much like modern peat, the other that it was drifted varying distances by river floods and sea currents away from the shore and becoming waterlogged sank to the sea floor where it soon became covered by other sodden rafts, and finally by sand and silt. The geography of the late Carboniferous times was undoubtedly exceptionally favourable to the accumulation and preservation of vegetable organic material. The continents at that time were apparently of low relief; the great activities of denudation during the Devonian period having abased the highlands previously uplifted to wide low-lying peneplains. Extensive coastal plains with vast peat moors of various types, including wood swamps, on the water sodden levels, fringed the slightly higher lands. Slight disturbances of the sea level would in such a case cause considerable disturbance on the lowland fens; either submerging them or allowing the currents to remove the peat elsewhere. Possibly considerable numbers of

timbers were brought down to sea from far inland forests by the great rivers of that time, although it appears that the great mass of the contents of the coal was lowland in plant types. As in peat the processes of decay did not complete their full course and much of the carbonaceous material of the ancient drifts has remained in the seams to the present day. Chemical changes there have been, chiefly in the proportion of hydrogen and oxygen in combination with the carbon.

Anthracite coal differs in many respects from ordinary so-called humic coal. It burns with a clear flame, and emits little smoke that corresponds to the lighter hydrocarbons. The mode of its deposition and also of its transformation from the mother substance to the present are both alike obscure. This at least seems plain; it is not derived by metamorphism from ordinary coal. The likelihood is that they are perfectly distinct and are the derivatives of two distinct types of vegetable mother substances. What the mother substance of anthracite was, we do not know.

Petroleum and oil shales have become of great economic importance during the past half century and especially so within the past 15 years as a result of the development of the internal combustion engine. The chief petroliferous areas at present exploited are in U.S.A., Russia, and the foot-hills of the Carpathians. The British Empire appears to be inadequately supplied. In England the Kimmeridge Clay, in Purbeck and Norfolk, includes rich oil-shales that await exploitation. The Midlothian oil-shale industry, despite the keenest competition and many natural difficulties, has maintained its prosperity for a long period already. Oil-shales must be distinguished from oil deposits. Only exceptionally does an oil-shale yield oil without distillation, the hydrocarbons being held in some sort of combination in the matrix of shale or sand, as a substance, termed kerogen. Little more can be said of this substance. As a rule the oil of the great oil fields is held as such in the midst of a sandstone or limestone. Frequently the rocks of the oil field are arched up into an anticline, the gas being originally at the top above the oil, which in turn rests upon brine filling the basin of the syncline, associated with the anticline.

Quite naturally a great variety of theories is held with regard to the origin of petroleum. These may be largely grouped into two classes, the inorganic theory or metallic carbide theory and the organic theory. According to the first idea the hydrocarbons found in the earth's crust were originally formed by interaction of water with metallic carbides at great depths, and later they made their way upwards through the covering of sedimentary rocks into the beds where they are now found. A variation of this opinion holds that mud volcanoes may well have been active in spreading out vast flows of mud rich in hydrocarbons. Certain evidence bears immediately upon this theory. Mendelejeff observed that many metallic carbides give hydrocarbons with water.

Sabatier showed that it was possible to form a series of hydrocarbons from acetylene by the action of metallic cobalt and nickel, acting as catalytic agents.

The upholders of the theory of the organic origin of petroleum are divided into two camps according as they favour a vegetable origin or an animal origin. Some suggest that petroleum has been derived in the main by the metamorphism of pre-existing lignite and coal by igneous intrusions or the liberation of heat during long protracted but considerable tectonic disturbances. The first oil-shale actually worked in this country was in close proximity to coal seams, and coal shales as a matter of fact do yield oil and gases on distillation. Coal and peat yield on appropriate treatment considerable supplies of hydrocarbons. The difficulty, however, is that they yield also coke and various oxygenated derivatives of the hydrocarbons which are to seek in petroleum deposits. It is also urged by some that oil shale was the mother substance of petroleum from which this was derived by distillation and that the kerogen of the oil-shale is vegetable in origin, being rich in the tarry and terpene products of plant assimilation.

The theory with the greatest support holds the original source to be animal in character. The diatoms, corals and other small fry of vast shallow seas are held accountable for much, without reckoning upon the higher types of marine life such as molluscs, fish, and in Jurassic rocks, saurians of various kinds. It is thought that a richly organic mud, a sapropel, accumulated in places on the floor of the sea and was enclosed before decay had gone too far by ordinary silt of sand and mud. During the passage of time the organic matter has, it is thought, suffered progressive chemical change and has been converted into a structureless substance in oil-shales, from which in most cases petroleum, gaseous and liquid, have been distilled by natural heat into overlying sandstones and limestones, the petroliferous oil-sands and limestones of modern oil fields. Most of the evidence available goes to confirm the opinion that the English oil deposits, chiefly in "kerogen" shales, are derived in the first place from marine organisms. There is little evidence favouring a purely inorganic mother substance as the source from which oil has come by chemical interaction.

Graphite is a form of elementary carbon and occurs in various degrees of purity in different states. It may be found crystallised in small hexagonal plates, as foliated lumps, thin layers, and compact masses of small or large dimensions. On the whole it is confined to crystalline rocks—to the ancient gneisses, mica schists and granites and to volcanic rocks. Rarely does it occur in sedimentary rocks. It is, however, recorded for some old limestones in Finland and in Ottawa, where in one place is a band of between 20 and 30 feet. It also sometimes occurs in meteorites as cubical crystals.

The origin of graphite is somewhat of a puzzle. Coal seams traversed by volcanic dykes occasionally show the coal metamor-

phosed to graphite. But how it was enclosed in igneous rocks as a secondary product of a previously existing organic accumulation is a question that has still to be answered. It is suggested, however, that petroleum, whether the product of organic substance or of some chemical interaction upon metallic carbides, made its way along veins and there deposited carbon, which in the lapse of time became graphite. One must confess that it is difficult to avoid the conclusion that some at least, if not the greater part, of the graphite found in rocks was derived from a purely inorganic source.

The diamond is the purest form of carbon found in nature. The geological features of its occurrence are matters of great scientific interest. In the greater number of its sources it occurs as isolated crystals in river wastes, in gravels, sands and conglomerates, that is in beds quite evidently derived from pre-existing rocks elsewhere. The diamonds of India, Brazil, Borneo and some localities in South Africa are alluvial in origin, and nowhere is the parent crystalline rock in which the diamond was conceivably generated to be seen. The Kimberley diamond fields are, however, of a different type. Here the gems occur as etched octahedra with curved edges and a greasy lustre, enclosed in a matrix, known as "blue ground." This blue ground is a green serpentinous breccia, which contains grains of an extraordinary variety of minerals; among them, garnets, green pyroxenes, altered magnesian mica and black ilmenite. It is evidently a much rotted volcanic rock. This volcanic agglomerate is confined to vertical pipes of unknown depth, some 200 yards or more across at the surface. The diamonds are scattered through the blue ground, generally loosely, but rarely as enclosures in fragments of a schistose rock, eclogite.

The question, how did the diamonds get into the pipes has called forth many suggestions. One suggestion is hazarded that the diamonds were encased in the body of the meteorites that rained down at some distant period in a rapid shower and have since been released by the decay of the meteoritic minerals. The so-called pipes, on this theory, would be simply holes drilled into the earth's crust by the tremendous impact of the meteorites. A remarkable feature, the Arizona meteoritic plain, supplies some sort of confirmatory evidence for this idea. There a broad plain five miles in width is scattered over by some 2,000 masses of metallic iron plainly of meteoritic origin. Further, on the plain rises a crater with raised unbroken edges, three-quarters of a mile across and 600 feet deep. The only possible explanation appears to demand some powerful impact of a colossal meteorite, remnants of which lie scattered on the plain outside. Some of these fragments actually contain black and transparent diamonds, besides crystals of carbon silicide.

Another more probable supposition is that the pipes consist essentially of an altered peridotite, an olivine rock from which the diamond has crystallised. Friedlander following on the mode

of the experiments by Moissan on the artificial formation of diamonds, stirred some melted olivine with a stick of graphite and found that the silicate on cooling contained very numerous but microscopical crystals, which he took to be diamonds. The blue ground in a similar manner dissolves diamonds when they are strongly heated with it.

The original source of the carbon of the diamond, it is suggested, was either graphite or carbon combined as petroleum, inorganic or organic in source, in underlying rocks, igneous or sedimentary, which was dissolved out of these rocks by the intrusive volcanic magma on its way to the surface.

Petroleum sometimes occurs on the surface of waters in the neighbourhood of Kimberley, and a solid hydrocarbon was actually extracted by Sir Henry Roscoe from the blue ground.

The pipes in the Kimberley district are not, Sir William Crookes shows, ordinary volcanic pipes. The surrounding walls show no sign of igneous action and are not shattered where touching the clay. It seems pretty certain that the pipes were filled from below after they had been pierced, the diamonds having been formed at some previous period in other than volcanic rocks and injected together with other rock debris into the pipes by a mud volcano. According to most South African geologists volcanic activity of this sort was prevalent all over South Africa during the Cretaceous period. It is, however, only in the northern parts of the country that the pipes as well as fissures and dykes are filled with the diamantiferous blue ground; elsewhere they are filled with volcanic agglomerate, breccia and tuffs and in places with basic lavas.

Cases of the occurrence of diamond in what might be the original matrix are remarkably few in number. It has been found with corundum in a decomposed pegamite vein traversing granite and also in a hornblende diabase intersecting granite as a dyke. Professor T. G. Bonney found eclogite in the blue ground studded with diamond crystals. This crystalline rock consists of pyroxene, garnet and a little olivine. It seems probable that a holo-crystalline pyroxene garnet rock like this was one source at least of the diamond. But of course the eclogite may not be the truly original matrix, but has simply caught up the diamonds from some other matrix now completely disintegrated, either from some deep seated crystalline rocks or as a concretion in the blue ground.

V.

The Uses of Carbon.

By HUBERT PAINTER, B.Sc., F.C.S.

(Delivered as a general Lecture at the Society's Room, April 29th, 1916).

IN the first lecture of this series I explained that carbon exists in the free or uncombined state in three or more forms or

modifications, and that, entering into combination with other elements, it forms part of an immense number of chemical compounds. In considering the uses of carbon it will be convenient to confine ourselves to those of the free element. Of the various modifications of this it seems natural to consider the diamond first.

This occupies a very high position among precious stones and has been greatly valued from very ancient times. It possesses an extraordinary lustre and exceeds all other gems in hardness. It occurs in various parts of the world such as India, Australia, Borneo, Brazil, and South Africa. In ancient times India was the chief diamond country. In the 18th century the Brazilian fields became known and the yield continued to increase up to the early fifties of the 19th century. The existence of diamonds in South Africa was known or suspected long ago, but it was not till 1867 that the first Cape diamond reached Europe. During the next thirty years (1867-97) diamonds to the value of £90,000,000 were exported from South Africa. The Kimberley mines had by the end of 1904 yielded ten tons of diamonds. This figure is given by Sir William Crookes. But diamonds are not usually sold by the ton, a very different unit of weight is used, namely, the carat. This unit has not the perfect definiteness that belongs to the Imperial pound or to the gramme, but has varied a little with time and place. In 1877 a syndicate of jewellers of London, Paris, and Amsterdam fixed the carat as 205 milligrams, equalling 3.163 grains. To realise somewhat better the value of the carat it may be noted that

1 ounce avoirdupois = 138.3 diamond carats.

1 ounce troy = 151.1 diamond carats.

1 sovereign weighs almost exactly 39 diamond carats

A new threepennypiece weighs almost exactly 6.9 diamond carats.

The fourth part of a carat is called a grain, but this diamond grain is clearly not equal to the grain used in dispensing medicines. Occasionally it may happen that a diamond is found so perfect in shape that it can be set as a gem without any preparation, but this is very rare. Cutting and polishing are required to bring out the full beauty of the stone. Before attempting to outline these processes it will be well to note (1) that in hardness the diamond far exceeds all other naturally occurring substances, (2) that this hardness does not prevent some degree of brittleness, (3) that the diamond can readily be split or cleaved in certain directions, namely, along planes parallel to the faces of the octahedron, which is its primary form of crystallisation. In former times it was not realised that hardness and brittleness could go together, and it was supposed that a diamond could not be broken on an anvil by a hammer. In fact Pliny says that Indian and Arabian diamonds are of such "indomitable and unspeakable hardness" that the attempt to break one on an anvil results in the shattering of anvil and hammer alike. This, of course, is absurd, and Sir Thomas

Browne pointed out in his work on "Vulgar Errors" (1646) that "Diamonds are so far from breaking hammers, that they submit to pistillation and resist not an ordinary pestle." They can, in fact, be reduced to powder in a steel mortar. This, however, is due to no lack of hardness. A very striking experiment was performed by Sir William Crookes at the B.A. meeting at Kimberley, September 5, 1905. I quote his description: "On the flattened apex of a conical block of steel I place a diamond and upon it I bring down a second cone of steel. With the lamp I project an image of the diamond and steel faces on the screen, and force them together by hydraulic power. I can squeeze the stone into the steel blocks without injuring it in the slightest degree." In doing this Sir William applied a pressure of 170 tons per square inch to the diamond. We now return to the cutting of the stones. The rough diamond in its natural state is first submitted to a most careful examination so that not only may its purity of colour be estimated, but also that any flaws or specks it may contain shall be detected. If any of these occur at or near the centre of the stone it will be necessary to make two or more approximately equal cut stones from the original, but in most cases it will be possible to make one chief stone. One or more of the split-off portions may be large enough to cut and polish as small diamonds or, in any case, they can be used for diamond dust. These points being settled, the diamond is inserted into a cement of brickdust and resin, made soft by heat, and contained in a ferrule projecting from one end of a wooden cylinder. When the cement is quite cold the operator takes another diamond having a sharp edge and cuts with it a scratch or notch in the one that is to be cleaved. When the notch is deep enough the wooden cylinder is fixed in a block of lead. Into the notch is inserted the blunt edge of a small steel blade, a quick sharp blow is struck on the blade and the stone is split. It is now taken out of the cement and put back again in the proper position for the next split and so on until the stone is of the general shape decided upon. From the cleaver the diamond goes to the cutter. He grinds two stones together until both are quite smooth, and thus further develops the facets produced in the rough by the cleaver or splitter. The third and last stage is that of polishing. This is done by means of diamond dust moistened with oil on horizontal wheels making about 2,000 revolutions a minute. In this, as in the other two operations, we have a good example of the extraordinary delicacy and accuracy of which skilled human labour is capable. Amsterdam has long been the chief seat of the industry, but it is also carried on in London, Paris, and other places. During all the processes the greatest care is taken that the precious dust shall not be lost. Diamonds are cut in various forms, among which the "brilliant" is the chief. The word is often used alone to indicate a diamond, but strictly it is a form to which other stones than the diamond may be brought. The typical brilliant has 58 polished facets. 33 of these, including the large central "table," are in the "crown"

or upper part; 25 in the "pavilion" or lower part, the central one of these, parallel with the table, but considerably smaller than it, is the "collet" or "culet." The "girdle" is the edge where the crown and pavilion meet and is mostly concealed by the setting. The "rose" was used as far back as 1520, but is now out of fashion. It is flat below and it forms above a low pyramid covered with facets. The number of these varies and may be 12, 24, or 36.

Although the typical diamond is colourless many specimens are tinted. The commonest tint is yellowish or brownish and may be present in all degrees from those in which the stone is just "off colour" to those in which it is nearly black. Such coloured stones are usually reckoned much inferior in value to those which are colourless and "of the first water." In certain cases, however, a coloured stone may, if the colour be very rare and very beautiful, greatly exceed in value a colourless stone of the same size. Of ruby-red stones only about two specimens are known although there are many, comparatively, with a rosy tint. A very few green diamonds have been found and a few blue ones. The best known of these is called the Hope Blue Diamond, a brilliant of $44\frac{1}{2}$ carats. Mr. Streeter has investigated the history of this stone. He says that in 1668 Louis XIV. bought a blue diamond, the first known in Europe, that came from India and weighed $112\frac{1}{4}$ carats in the rough. Louis seems to have had this cut and wore it when in 1715 he gave audience to the Persian Ambassador. The stone, reduced by the cutting to $67\frac{1}{8}$ carats, formed part of the French Regalia seized in the Revolution and it disappeared in September, 1792. The Hope Diamond appeared in 1830, no account as to its origin or history being forthcoming. Mr. Streeter has no doubt that it is part of the blue diamond of Louis XIV., and he has traced two smaller fragments of the same stone, one being the "Brunswick Blue Drop" and the other, a stone of 1 carat, he found in Paris and bought for £300.

Many of the larger and more valuable diamonds have proper names and histories. The history of the Koh-i-nur can be traced back, for instance, for more than 600 years. It forms part of the Crown jewels, was recut in 1851 and now weighs about 106 carats. Other famous Indian diamonds are the Orloff, the Regent and the Sancy. The largest known Brazilian diamond is the Star of the South. This was found in 1853, weighed $254\frac{1}{2}$ carats before and 125 carats after cutting. It was bought by the Gaekwar of Baroda for £80,000. From South Africa many large diamonds have come. The Victoria, weighing 180 carats, was cut from a rough stone of $457\frac{1}{2}$ carats, the Nizam of Hyderabad gave £400,000 for it. In 1893 the Excelsior was found. This was the largest that had, up to that time, been discovered. It weighed 971 carats and was cut up into 10 stones varying from 68 to 13 carats. The largest diamond ever found was the Cullinan, discovered in January, 1905, in the mines of the Premier Diamond Mining Company. This monster weighed in the rough $3,025\frac{3}{4}$

carats, or about $1\frac{1}{3}$ lbs. It was bought by the South African Government for £150,000 and presented to King Edward. It was of fine whiteness, but contained flaws so that it was cut up into a number of gems, of which the largest weighs $516\frac{1}{2}$ carats.

Diamonds of inferior quality which, owing to bad colour or imperfect crystallisation, are useless as ornamental stones serve, when crushed in steel mortars, to supply the diamond powder or dust used in polishing diamonds and other stones. They are often called bort (also spelt boort and boart), although the strictly mineralogical use of the name is limited to a special variety of diamond found in nodules, rough externally, usually dark in colour and showing when broken a radiated internal structure. In density bort is a trifle inferior to true diamond, but it is distinctly harder and thus more useful as an abrading agent. In the year 1845 another variety of diamond, called carbonado, was discovered in Brazil. It occurs in small masses of dark grey or black colour, appears to be an irregular aggregate of minute crystals and is much harder even than bort. It has been found in Borneo, but not in India, nor, as far as I know, at the Cape. Although useless as an ornament its extreme hardness causes it to be highly valued, and its price has risen from 1s. per carat to £10 or more. Classing together ordinary diamond, bort and carbonado as adamantine carbon we may now rapidly run over some of the various uses of this form of the element. The ornamental use has been sufficiently dwelt upon and so has its application in cutting and polishing precious stones in general. The glazier's diamond is a fragment with a sharp edge fixed in a suitable handle. By its means glass plates can readily be cut into any desired sizes and shapes. A deep scratch is made along the line in which the glass is to be cut and this determines the direction in which it will split off when a gentle force is appropriately applied. A diamond drill is useful for making holes in glass and in porcelain, and hence is a most valuable tool to the riveter of broken china. I believe that dentists also sometimes use such drills. On a large scale the diamond drill is used in rock boring. Pieces of diamond or, better, carbonado, are imbedded firmly in a steel ring known as the "crown." This is secured to a series of hollow tubes so that the length can be increased as required. The rods are rotated by steam power at the rate of about 250 revolutions per minute and a pressure of perhaps half a ton or so is brought to bear on the crown. Carbonado will stand a pressure of 35 tons to the square inch while rotating at this high speed and hard granite can be bored through at a rate of 3 inches or so per minute. Water is kept circulating through the tubes to keep the crown cool and wash off the debris formed. Diamonds have also been used for bearings in chronometers and electric measuring instruments of precision, also in turning, as for example in the final adjustment of the axis of an astronomical transit instrument. Engraving on glass can easily be done with a diamond. Thus lines can be ruled on glass with a diamond point by means of a

dividing engine at the rate of many hundreds to the inch. Pieces of glass so ruled are known as diffraction gratings and used in the production of pure spectra. Gratings have been prepared having 4,500 parallel and equidistant lines drawn within a square of $\frac{3}{4}$ in. side. Yet another use is in wire-drawing. A hole is drilled through a diamond and the wire drawn through it.

I now turn to another division of my subject. Carbon manifests itself to us not only in the imperial diamond of magnificent lustre and "indomitable, unspeakable hardness," but as the soft and black graphite. German philosophy could hardly supply us with such another example of the synthesis of apparent irreconcilables into a unity. Carbon is hard and white, but it is also soft and black. With the geology and geographical distribution of graphite other lecturers have dealt, but I may remind you that it is obtained from Siberia, Ceylon, Bohemia, Bavaria, North Italy, and the U.S.A. The excellent graphite of Borrowdale in Cumberland has, unfortunately, been exhausted. It is also made artificially and, since the introduction of the electric furnace into technical use, this artificial graphite is of considerable importance. The name graphite indicates its use for writing, other names which still cling to it, black lead and plumbago, are relics of a time when its chemical nature was not understood. Lead pencils, as we still call them, appear to have been made originally from slips of natural graphite cut out from the native mineral and enclosed in a wooden cylinder. Natural graphite good enough to be used in this way was, I believe, once found in Borrowdale, but the supply was very small and soon exhausted. It was found, however, that satisfactory pencils could be made from graphite of less super-excellent quality. Briefly, the process is as follows:—The graphite is ground, washed and sifted so as to remove all traces of grit. The purified product is mixed with clay that has been similarly treated and the mixture, with the aid of some other ingredient to bind it together, is made into a paste. This is squeezed through a hole and issues as a soft thread of the proper size. It is next dried and afterwards baked, thus becoming hard and suitable for insertion into a groove, made by a machine, in a piece of wood having the shape of a half cylinder. A similar piece of wood is glued to this and the cylinders are cut up into the conventional lengths, stained, polished and stamped with the maker's name, etc. According to the proportion of graphite and clay the pencils are of various grades, known in England by the letters B and H or these in combination. Thus B = black, H = hard, HB = hard and black, BB = very black, HH = very hard and so on. Besides their legitimate use in writing lead pencils come in for other purposes. The "lead" of a hard pencil may be used in the chemical laboratory as a cheap substitute for platinum wire in performing what are called flame reactions.

The use in writing depends, of course, on the comparative softness and blackness of graphite, properties which fit it for making marks on paper, and the ease with which such marks can,

when necessary, be erased is a great further convenience. Another very important use depends on the infusibility of graphite. Although it can be burnt to carbon dioxide it is ignited with great difficulty. This property, together with the infusibility just mentioned, fits it for making crucibles, retorts, twyer pipes and similar purposes. (Twyer pipes are the pipes through which air is blown into furnaces, e.g., into the blast furnaces used in smelting iron). For crucibles it is freed from grit, mixed with Stourbridge clay, and made into a paste with water. The kneaded mass is left to itself for a long time, several weeks as a rule, then moulded, very slowly dried and very carefully fired. Crucibles made in this way are very largely used in metallurgical operations. The Morgan Crucible Company, Limited, very kindly supplied me with a set of lantern slides for exhibition in this lecture, illustrating the use of their crucibles in a number of such operations. At the present juncture in national affairs this particular class of the uses of carbon is of special interest. Graphite crucibles are playing an important part in that marvellous production of munitions of war upon which so much depends and without which we should not be here in security giving a lecture or listening to it, but should either be dead or miserable captives of the modern Sennacherib.

The smoothness and slipperiness of graphite make it of great value as a lubricant for diminishing friction. Sometimes it is used dry, at other times mixed with grease or oil. It is extensively employed in connection with machinery or various kinds to ensure the smooth running of the moving parts. The bicycle chain is one of the most familiar examples. In making boots and shoes powdered graphite is often placed between layers of leather in the sole and at the junction of the "waist" of the boot with the sole to prevent the squeaking noise which is so objectionable. Black-lead is also used in the joints of artificial limbs. A special but melancholy interest attaches to this particular use at the present time when so many of our gallant soldiers are obliged to resort to artificial substitutes for limbs lost in the service of their country.

The unalterability of graphite in air renders it suitable for protecting metallic surfaces. Sometimes it is mixed with linseed oil and applied as a paint, whereas it is used dry for protecting and polishing stoves. Unlike the diamond, graphite is a good conductor of electricity and hence is used in electrotyping. Suppose it is desired to copy a seal in copper. An impression is made in wax or other suitable plastic substance. As wax is a non-conductor of electricity we cannot deposit the copper upon it direct, but, if coated with graphite, we can do so easily. There are other electrical uses of graphite, some of which I may mention later, but for the present use we will pass on to the third form of carbon, the amorphous, of which charcoal is one of the most familiar examples. Wood charcoal is prepared by the action of heat upon wood with more or less complete exclusion of air. The old method, suitable for use when wood is abundant, is to build a

pile of wood logs with some channels for air, covering it with a layer of turf and setting it on fire. Combustion begins, but the supply of air is purposely made too small to allow it to proceed far. The wood gives off various gases and other volatile substances under the influence of the heat and a residue of charcoal remains. This is nearly pure carbon, but it still contains a little hydrogen and the mineral matters which, if the wood had been completely burnt, would have been left behind as ash. The construction of the pile varies in different places. The wood may be placed vertically or, as in Sweden, horizontally, and the fire may be applied at the top or at the bottom. I do not know whether charcoal-burning is still carried on in this country in the old-fashioned way, it certainly survived until quite lately. A far more economical way of making charcoal is by heating wood in retorts somewhat after the fashion of those in which coal is heated for gas-making. The volatile substances given off are collected and from them acetic acid, naphtha and creosote are prepared. The yield of charcoal is about 25 per cent. of the weight of wood used. Charcoal is used as a domestic fuel in many countries and in the extraction of metals from their ores. The very best iron, for example, is that made from magnetite with charcoal as fuel; both it and the ore being free from the sulphur which is so objectionable an impurity in the metal. Charcoal is also used in the conversion of iron into steel by the cementation process. Bars of iron are imbedded in charcoal and the whole heated until the iron has taken up the required proportion of carbon. The lower parts of gate posts, telegraph poles, and the like are often charred so as to convert the outer layers of the wood into charcoal and thus preserve it from decay. According to an article in the "Saturday Magazine" for January 2nd, 1836, charcoal, being imperishable, has been used as "an enduring landmark, although a truly inconspicuous one, the custom being to bury it beneath the soil on the boundary." Wood charcoal has a great capacity for absorbing gases and is used as a disinfectant and deodorizer, thus it is often put at the ventilating openings of sewers and the like. A similar service is performed by the lump of charcoal put into a hyacinth-jar, or, mixed with fibre, into flower pots. Charcoal is used for filtering, domestic charcoal-filters, for use in country places with a water supply of doubtful purity, were at one time very common. In the chemical laboratory blocks of charcoal are much used and charcoal is as familiar and useful to the artist as to the student of science. In medicine it is used both for internal administration and externally as a poultice. Alone or with other ingredients it makes an excellent tooth-powder. Some dyspeptics think highly of charcoal biscuits, but it cannot be reckoned as a food. I have left to the last perhaps the most important of the uses of wood charcoal, the manufacture of gunpowder. This contains somewhere about 15 per cent. of charcoal, 10 per cent. of sulphur, and 75 per cent. of nitre, although the proportions vary. By heating bones in iron retorts, bone black,

an important form of animal charcoal, is obtained. Another form is prepared by charring dried blood. Bone black contains a large proportion of earthy salts, chiefly phosphate of lime. When these have been removed by the action of acidulated water the washed and dried product is the animal charcoal so useful in removing colouring matters from organic compounds. Bone and blood charcoals are largely employed in sugar refining and bone black is also used in the preparation of black pigments.

Coke is related to coal in the same way that charcoal is related to wood. It is obtained as a secondary product in the preparation of coal-gas and is the principal or primary product of the coke-oven. It contains about 92 per cent. of carbon, the remainder consisting of the mineral matter that was present in the coal from which it was made together with small amounts of hydrogen, nitrogen and sulphur. It is much used as a fuel, especially in smelting operations and other cases in which a very high temperature is required. When steam is brought into contact with highly heated coke it yields water-gas, a mixture of hydrogen and carbon monoxide. This is a valuable gaseous fuel and is used by our local Gas Company for mixing with ordinary coal gas. Soot is another familiar form of impure carbon, it results from the imperfect combustion of coal. It is partly deposited in our chimneys and partly escapes from them with the smoke, forming a constituent in that complicated mixture known as fog. Soot contains an appreciable quantity of ammonia compounds, and it is to these that its usefulness as a manure is due. Lampblack is a kind of specially prepared soot, which has many applications. Such combustibles as tar, resin, turpentine, and petroleum are burnt with a supply of air so small as to produce a flame rich in smoke. This passes into chambers where the finely divided carbon is deposited in coarse cloths. For the finer kinds metallic cylinders revolve over special lamps burning with very smoky flames. The crude lamp-black is purified by heating it in closed vessels. The imperfect combustion of the natural gas of the oil-producing districts of the United States has also been largely used in making lamp-black. This form of finely divided amorphous carbon is employed as a pigment, forming the bases of both oil- and water-blacks. Indian or Chinese ink is made from the purest and best lamp-black mixed with a solution of some gummy substance. It is said that for the very finest Chinese ink camphor black is used. Printers' ink also is made from lamp-black diffused through an oily or greasy medium. Resin and other cheap oils serve for the commoner varieties of this ink, but the better kinds are made from good lamp-black and drying oils, such as linseed or poppyseed, which have been strongly heated and so converted into a kind of varnish. Lithographic ink is a very carefully prepared printing-ink of special quality. The ink used for "blacking-out" in connection with the press censorship is diluted printing-ink.

The typewriter is a kind of cousin to the printing press and is equally dependent upon carbon-containing inks. The black

paper by which two copies of a bill are made at one writing is a yet further example of the use of lamp-black. For taking rubbings of monumental brasses a composition known as heel-ball is employed. The primary use of heel-ball is for blackening the heels of boots and shoes. This suggests the various blackings, pastes, polishes and varnishes having a carbon basis and serving to protect and beautify the leather of our boots and shoes.

For the "Carbon process" used in photography a film of gelatine is intimately mixed with very finely divided carbon and sensitized by ammonium bichromate. This process has, I believe, been used in making the extensive "Autotype" series of reproductions of celebrated paintings, but it is, perhaps, only fair to say that other pigments sometimes replace the carbon. When a piece of glass is passed through a candle flame it becomes coated with a layer of lamp-black. Such smoked glass is useful for observing the sun during the progress of an eclipse or for examining its disc when affected by sun-spots large enough to be visible without telescopic aid. Another use of smoked glass is in the preparation of lantern slides. Slides of this kind can be very rapidly made and many of us have learned the results of Parliamentary elections by this means.

I began with the diamond as a means of personal adornment. The form of carbon easily obtained by scorching a cork is used, if not as an adornment, as a part of the professional get-up of the street minstrel. Indian ink, or some similar preparation, is used in tattooing, a form of decorating the person very widely diffused. By way of conclusion to my remarks on the artistic uses of carbon I may remind you of three important media used in drawing: charcoal, Indian ink, and the pencil. Each of the three has its own advantages and limitations, but of these I am not competent to speak.

The electrical applications of carbon are very numerous. One or another form of it is used in the arc lamp, in the construction of Leclanché and other cells, in a great many electrolytic operations both on the manufacturing and the experimental scale, in the making of collecting brushes for dynamos, in some forms of telephone and microphone receivers and for many other purposes.

Here I bring to an end my catalogue of uses of the element carbon in a free or uncombined state. To attempt to recount the uses of the compounds of carbon would be a hopeless task. Every substance of animal or vegetable origin might be cited, every article of food and of clothing besides the huge number of compounds which the art of the chemist has prepared from coal, wood and petroleum. Again, we are at present almost entirely dependent for artificial heat upon the combustion of carbon or carbon-containing substances, so that, indirectly, carbon is required to enable us to make use of the mineral wealth of the world. A complete account of the uses of carbon and its compounds would be but little short of an account of human life in its material aspect and of all the arts of war and peace.

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